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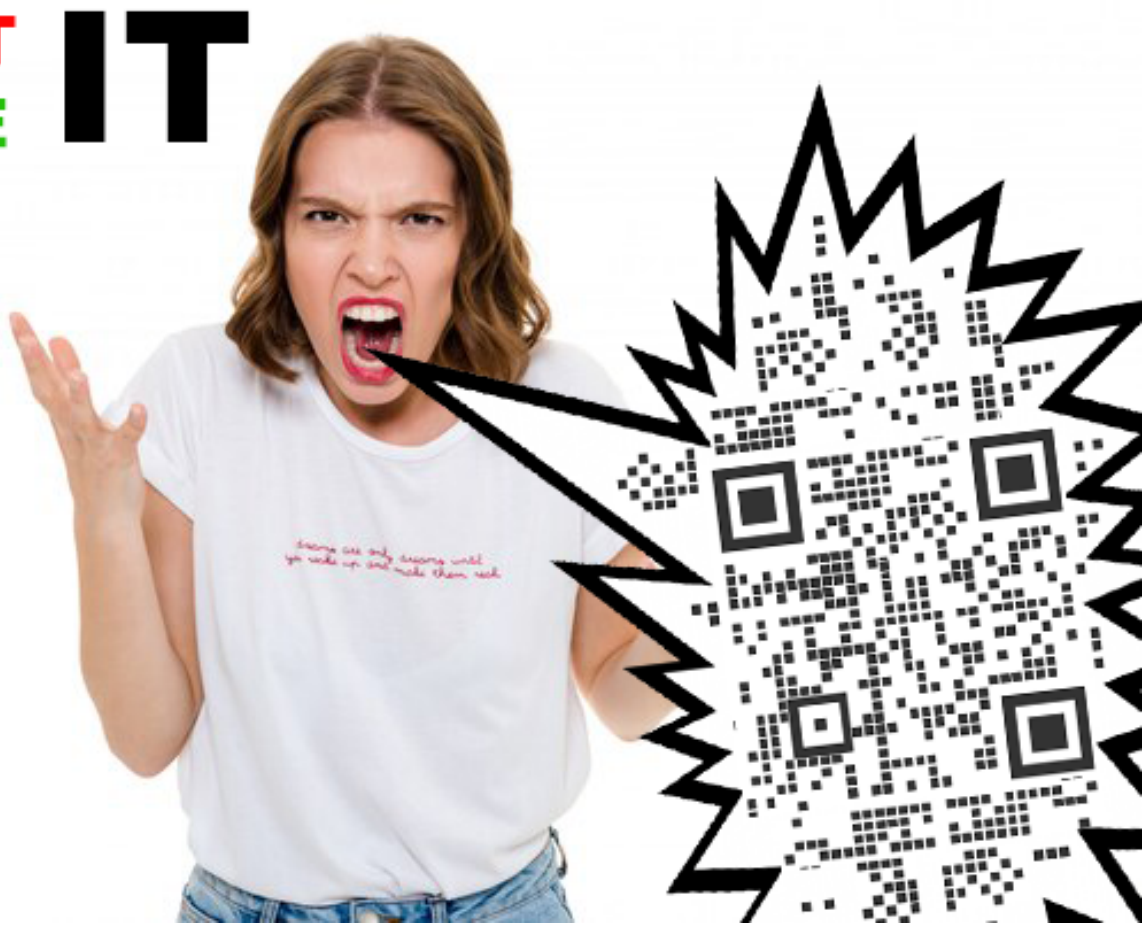

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Editorial

Animal Rights! Species Wrong!

During the last 30 years, animal rights movement in the world (Singer 1975, Rollin 1981, Regan 1983) and in India has grown from strength to strength, whether it is the question of transport of animals or the question of minimum space provided to display animals in zoos, or the treatment of circus animals. This is certainly a good development – an indication of a mature and humane society. We all agree that college laboratories should avoid or minimize experiments on animals, especially if they are collected from the wild (e.g. frogs, lizards, scoliodon), and research laboratories should keep experimental animals in healthy conditions. Experiments that are inhuman and painful should be avoided, since many can now be simulated in computers. Who would not agree that our zoos need total reform? The naked cages should be replaced by large enclosures with moats and natural barriers, and zoo animals should have some private areas, where they can retreat from time to time. Animals living in groups (e.g. most deer species) should not be kept in solitary confinement, and solitary animals (e.g. Leopard, Tiger) should be provided enough space so that they feel comfortable. Inquisitive animals such as apes and monkeys should be provided emotional enrichment and novelties in food and for play, so that they are kept busy and happy.

On the wildlife front, we should see that more attention is given to habitat and species protection, that poaching is strictly controlled, the number of protected areas is increased to include all the species and ecosystems, the forest guards are better trained and equipped, and the local communities benefit from biodiversity conservation. I think no one would have any objection to the above-mentioned suggestions. The problem comes when animal rights activists start interfering in conservation action and management. Good conservation is a different ball game. I will give a few examples to illustrate how animal rights activism and emotional conservation are playing havoc with the conservation movement in India.

Along with habitat loss and over-exploitation, invasive species are the second greatest threat to biodiversity conservation in the world (BirdLife International 2001). Both animal and plant invasives are playing havoc in India. There are numerous examples, such as *Lantana camara* in the Indian forests (Sawarakar 1984); *Prosopis chilensis* or Mesquite in northwest India; *Parthenium* in disturbed areas (Sushikumar and Saraswati 2001); *Mimosa* in Kaziranga (Vattakkavan *et al.* 2005); Water Hyacinth *Eichornia crassipes* in almost all tropical wetlands; crows, cats, elephants and Chital in Andaman Islands (Ali 2004); Andaman Red-whiskered Bulbul *Pycnonotus jocosus whistleri* on Nancowry group of islands of Nicobar (Sankaran 1998); goats on Narcondam Islands (Vijayan and Sankaran 2000); and feral dogs on Great Nicobar (Ali 2003). While most conservationists and animal lovers agree that plant invasives should be removed to save local fauna and flora, when the question of eradication of invasive animals is brought up we hear howls of protest.

Biological invasions are now considered to be one of the world's most challenging environmental threats (Vitousek *et al.* 1996; Parker 2000). Invasive species are entirely or partially responsible for the majority of bird extinctions since 1800. Introduced predator species, particularly cats, rats and mongooses, are currently threat to nearly 25% of the globally threatened bird species (BirdLife International 2000). Most of these extinctions have occurred and still occur on small remote islands, where birds lack natural defences to introduced predators, such as cats, foxes, rats, mongoose, crows etc. These invasive animals are commensal of man and travel with him, or are sometimes deliberately introduced. India is a continental country so we do not have many such examples, except in the Andaman & Nicobar and Lakshadweep Islands. Nonetheless, on our islands, the story is not very different to what had happened in New Zealand, Hawaii and many other islands. According to a very interesting study by Dr. Ravi Sankaran of the Sálim Ali Centre for Ornithology and Natural History (SACON) (Vijayan and Sankaran 2000), goats introduced by the Indian Government to provide fresh meat to the policemen were playing havoc on Narcondam Island by browsing saplings of *Ficus* species. Most nests of the Narcondam Hornbill (*Aceros narcondami*) are found in old, fissured and hollowed trees (Hussain 1984, Vijayan and Sankaran 2000, Yahya and Zarri 2002). Due to storms and old age, many trees die every year on this small, 6.8 sq. km island. The nest sites are at premium and out of the 300-400 Narcondam Hornbills that occur there, there is a stiff competition for nest sites.

The goats are not allowing regeneration so there is very little recruitment. Based on his fieldwork, Ravi believed that if the goats were not eradicated and the old trees keep dying at the present rate (no one can stop this), then in another 80 years there would be no old tree left to have nest cavities for this highly endangered and endemic species to breed. The question is: what is more important? Goat, the most widely distributed domestic animal in the world, or the Narcondam Hornbill, which lives only on this 6.8 sq. km island and has a population of less than 400 individuals? Shouldn't hard-core conservation measures over-rule the bleeding heart's maudlin appeals to protect goats? Which is more important: the Narcondam Hornbill's right to exist, or the feral goat's right to nibble away the last *Ficus*? Fortunately, most of the goats were removed from the island in 1999, and while it is possible that a few stragglers survive in remote corners, a major threat has been averted by the implementation of good conservation practices, based on good science. But do we have many such examples? This was possible to do on a remote island, away from the prying eyes of vocal animal rights buffs. Can we do this on the mainland?

Another example from the Andaman Island is the ecological havoc by the introduced Chital (*Axis axis*) (Ali 2004). The British introduced this prolific deer nearly 100 years ago. Since then they have spread to most islands in the group. Like many volcanic islands, the rainforest of Andaman & Nicobar has also evolved without grazing and browsing pressures from large herbivores. Till about three decades ago, the number of Chital was kept under control by legal hunting, but now that has more or less stopped. Chital is in Schedule II in the Indian Wildlife (Protection) Act, 1972 and its hunting is totally banned. Conservationists have repeatedly recommended to the Government to control the number of Chital by allowing hunting in large islands, and total eradication from smaller islands, the local flora and ecosystem would be otherwise irreversibly damaged (Ali 2004). The Shekar Singh Committee-2002 that was supposed to look at conservation issues of Andaman & Nicobar Islands has recommended darting of the alpha male Chital with anti-fertility drugs to control the population of this gregarious animal. An emotional protectionist's philosophy has again won over practical conservation. Firstly, it is not easy to selectively dart/catch alpha male Chitals, secondly as soon as dominant alpha males lose their vigour, the subdominant males would become dominant quickly and do the 'job', perhaps happily! Thirdly, when you are catching this invasive species, why not eat it. Chital is anyway one of the most widely distributed deer in India and Sri Lanka. What is more important in small remote islands of Andaman: ecosystem integrity or the prolific Chital? We have a national obligation to eliminate invasive species under Section 8 h of the Convention on Biological Diversity (CBD). India has signed the CBD, so why are we shying away by not taking some concrete actions (merely to placate animal rights activists?).

It is not only the feral invasive species that are the problem for biodiversity conservation. Even our domestic animals are a big problem for wildlife, especially in urban and semi-urban areas. Nearly 40% of wildlife survives outside protected areas, and many species live in a large landscape or waterspace. These species are already under tremendous biotic pressures; do they need dogs, cats or crows to put more pressures on them? The Black-necked Crane *Grus nigricollis* is a Vulnerable species (BirdLife International 2001) and about 55-60 individuals are found in Ladakh (a much bigger population of several thousands birds is found in Tibet). In India, 10-12 pairs nest every year in the high altitude lakes of Ladakh. According to Pfister (2004), nearly 50% chicks fall prey to semi-feral dogs in certain years. If we have such a small population, should we not control the population of these dogs and save the chicks of this Vulnerable species? In the high alpine regions of Upper Sikkim (Ganguli-Lachungpa and Rahmani 2005), abandoned dogs, some of which have now become feral, move in packs and kill Himalayan Marmots *Marmota bobak*, Hill Fox *Vulpes montana*, Tibetan Fox *V. ferrilatus*, Woolly Hare *Lepus oiostolus*, Tibetan Snowcock *Tetraogallus tibetanus* and highly threatened Tibetan Gazelle *Procapra picticaudata* and Kiang *Equus kiang*. I have seen dogs swimming in the high altitude lakes after Brahminy Shelduck chicks and digging up Marmot burrows. These aggressive dogs also chase the Snow Leopard *Uncia uncia*, Lynx *Lynx lynx* and Tibetan Wolf *Canis lupus chanko*. The Snow Leopard, Tibetan Wolf, foxes and various species of weasels and stoats are the natural predators in the alpine and semi-alpine regions. They occur in low densities and their predatory pressure is not enough to disturb the natural predator-prey balance, but when large aggressive, packs of feral dogs come on the scene, the balance is tilted against the prey species. Therefore, should we not control the number these domestic/feral dogs to save the globally threatened Black-necked Crane or the clumsy Himalayan Marmot? On many beaches feral dogs are the major problem for the nesting sea turtles, as they dig up the nests.

For small birds, with cutting of trees and bushes, and pollution our urban environment is becoming a nightmare to live in. To top this we have the menace of ever-increasing number of crows and cats. Which Bulbul

or Iora would be able to raise her chicks when hundreds of crows and cats are prowling all around her? In the United Kingdom, millions of birds are killed every year by domestic cats. Controlling the cat numbers is such an emotional issue that even a million-member Royal Society for the Protection of Birds is not willing to take up the cudgel with the fanatic animal rights activists. Despite thousands of dog bites every year, and many human deaths, animal rights activists have become so strong and vocal that killing of a stray dog in Mumbai becomes front page news! There is even a Stray Dog Welfare Association in Mumbai!

Most of our cities are now full of stray dogs, thanks to the ban imposed on their killing. Van Vihar National Park near Bhopal is a large zoo with big open enclosures. Recently, a pack of stray dogs killed ten Chitals in an enclosure. Another sordid example is the release of more than 700 dogs in Nauradohi Wildlife Sanctuary by the Municipal Corporation of Sagar, Madhya Pradesh. Faced with a public outcry over rise in dog bites, owing to a huge increase in the population of stray dogs in the town, the Municipal Corporation authorities decided to release the dogs in a sanctuary, on the recommendations of animal rights activists, thus not violating the ban on killing of stray dogs imposed by the State Government. Isn't it time for the real conservationists to stand up to these extremists. Dogs and cats are undoubtedly wonderful pets, but the question is: should we allow them to run 'wild' in our cities, towns, countryside and sanctuaries? According to me, every dog should be a pet dog, with a responsible owner who takes care of it. We do not need stray dogs, rummaging on garbage bins, biting children, chasing late-returning working women, and barking continuously in the middle of the night in residential areas. I would like to see a bulbul successfully raise her brood in my backyard as much as I would like to see a pet dog or a cat with a responsible owner.

Another issue that the Government is afraid to tackle is the problem of locally over-abundant animals such as Nilgai *Boselephus tragocamelus*, Blackbuck *Antelope cervicapra* and Wild Pig *Sus scrofa*. All these species are prolific breeders and have increased to pest proportions in many agriculture areas. For example, in 1983-84, there were not more than 20 Blackbuck and 60-100 Great Indian Bustards in and around Rollapadu (Manakadan and Rahmani 1989). Once the Sanctuary was declared for the protection of the highly endangered Great Indian Bustard *Ardeotis nigriceps*, protection was given to all species. Initially, local people were very happy that their area was coming into limelight due to the bustard and wholeheartedly cooperated with the Forest Department, but within a decade when the population of Blackbuck went up steeply and became a menace to their crops, the villagers turned against the Sanctuary. From being friends of the Great Indian Bustard and the Sanctuary, they have become enemies of both, and rightly so. Which marginal farmer would allow his crops to be destroyed year after year? While the Blackbuck numbers have gone up from 20-25 to 800, the bustard has declined from 60-100 to 30-37 (Thulsi Rao and Javed 2005). Recently, the Andhra Forest Department has taken some measures by translocating about 150 Blackbuck, but are we solving the problem or translocating the problem? While we still have some hope to save the bustards of Rollapadu, there is no hope left to bring back the bustards of Karera Bustard Sanctuary in Madhya Pradesh and Sorsan Bustard area in Rajasthan. What is happening in Rollapadu now happened in Karera and Sorsan a decade ago. Sadly in both these areas, the Great Indian Bustard is now extinct. In both Karera and Sorsan, crop-damage related resentment has created so much hostility that villagers are demanding denotification of the sanctuaries.

While I would not say that culling locally abundant species should be the first option, but can't we keep this as the last option in certain cases, for certain species and for certain areas? In the present conservation atmosphere in India, wildlife managers are afraid to even discuss this option due to strong backlash from animal rights activists and emotional city-based conservationists. To save endangered species, we should do everything and anything, even if it involves culling of certain animals or control of predators. We should have a menu of options such as strict control on poaching, habitat manipulation, translocation, improving the gene pool in small populations, conservation breeding and reintroduction, eradication of invasive species, and culling of common species, if they are impacting the recovery of endangered species.

As someone has rightly said, animal rights activists are interested in protecting every individual animal, while conservationists are interested in saving species and ecosystems. The two are not necessarily the same, and most of the time animal rights activism interferes in saving species and ecosystems. As we have seen from the above-mentioned cases, 'animal rights' can be species wrong!

Asad R. Rahmani

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TROPICAL RAINFOREST BIRD COMMUNITY STRUCTURE IN RELATION TO ALTITUDE, TREE SPECIES COMPOSITION, AND NULL MODELS IN THE WESTERN GHATS, INDIA[1]

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Studies of species distribution on elevational gradients are essential to understand principles of community organisation as well as to conserve species in montane regions. This study examined the patterns of species richness, abundance, composition, range sizes, and distribution of rainforest birds at 14 sites along an elevational gradient (500-1400 m) in the Kalakad-Mundanthurai Tiger Reserve (KMTR) of the Western Ghats, India. In contrast to theoretical possibilities, resident bird species richness did not change significantly with elevation although the species composition changed substantially (<10% similarity) between the lowest and highest elevation sites. Constancy in species richness was possibly due to relative constancy in productivity and lack of elevational trends in vegetation structure. Elevational range size of birds, expected to increase with elevation according to Rapoport's rule, was found to show a contrasting inverse U-shaped pattern because species with narrow elevational distributions, including endemics, occurred at both ends of the gradient (below 800 m and above 1200 m). Bird species composition also did not vary randomly along the gradient as assessed using a hierarchy of null models of community assembly, from completely unconstrained models to ones with species richness and range-size distribution restrictions. Instead, bird community composition was significantly correlated with elevation and tree species composition of sites, indicating the influence of deterministic factors on bird community structure. Conservation of low- and high-elevation areas and maintenance of tree species composition against habitat alteration are important for bird conservation in the southern Western Ghats rainforests.

Key words: structure and floristics, mid-domain effect, non-equilibrium dynamics, null models, community assembly

INTRODUCTION

Since the pioneering work of Terborgh (1971, 1977, 1985) and Terborgh and Weske (1975), research on altitudinal distribution patterns of birds has tended to focus on three major aspects — variation in richness with altitude, range sizes, and species turnover rates — and on one region with relatively well-documented information on bird altitudinal distributions, the Neotropics (Rahbek 1997; Patterson *et al.* 1998; Stotz 1998; Blake and Loiselle 2000). Most studies have shown a general pattern of decreasing species richness with increasing altitude, believed to mirror the well-recognised latitudinal gradient in species richness (MacArthur 1972; Patterson *et al.* 1996, 1998; Bachman *et al.* 2004). Monotonic decline in species richness with altitude may also occur when altitudinal range sizes of species increase with altitude, as suggested by Stevens (1992) in an extension of Rapoport's rule, a matter of intense debate (Rapoport 1982; Gaston *et al.* 1998; Taylor and Gaines 1999).

Other studies have suggested that species richness may show a non-monotonic, hump-shaped pattern with diversity peaking at mid-altitudes (Janzen 1973; Rahbek 1997; Stotz 1998), as in diversity-productivity gradients (Rosenzweig and Abramsky 1993). This pattern may become apparent when data are corrected for sampling effort for local species richness (Terborgh 1977; Patterson *et al.* 1996), or area for regional species richness (Rahbek 1997; Bachman *et al.* 2004). Models that evaluate consequences of geometric constraints (hard upper and lower limits) on the altitudinal ranges of species also predict mid-altitude peaks called the 'mid-domain effect' (Rahbek 1997; Colwell and Lees 2000; Veech 2000).

In contrast to species richness, community compositional change (turnover rates) at the regional level may increase with altitude (Rahbek 1997), or show peaks and troughs corresponding to transition zones between lowland and montane avifauna (Patterson *et al.* 1996; Stotz 1998). Little is known of factors influencing bird community composition at local levels in tropical rainforests. Along successional gradients, habitat structure and tree species composition influence bird community structure, wherein structurally and floristically similar sites have more similar bird communities (Raman *et al.* 1998). Along altitudinal gradients, past studies of local bird community structure have largely ignored the relative influence of deterministic differences between sites in habitat attributes versus the effects of chance, null models, or altitude *per se*.

The present study explores variation in local bird

community structure, species composition, and turnover rates along an altitudinal gradient in a tropical rainforest of the Western Ghats of India. Although recognised as a global biodiversity hotspot (Myers *et al.* 2000) and an endemic bird area (Stattersfield *et al.* 1998), this region is peculiar in being relatively depauperate in its rainforest bird community due to historical isolation from larger tracts of rainforest in northeast India and southeast Asia (Daniels *et al.* 1992). Here, we explore how bird community attributes vary with altitude in tropical rainforest. Specifically, we ask: does species richness show a monotonic decline with altitude or a hump-shaped pattern due to the 'mid-domain effect'? Is there support for Rapoport's rule? Does altitudinal distance and degree of change in habitat influence and correlate with change in bird community composition or are turnover rates estimated accurately by null models that simulate non-equilibrium dynamics? The results are used to assess the relative influence of deterministic *versus* non-equilibrium factors on tropical rainforest bird community structure.

MATERIAL AND METHODS

Study area

The 1600 km long chain of hills called the Western Ghats runs along the west coast of the Indian peninsula from 8° N to 21° N. Moist forests, including tropical wet evergreen forest, are found largely south of 16° N (Pascal 1988), and contain a higher diversity of endemic plant and animal taxa (Ali and Ripley 1983; Daniels 1992; Kumar *et al.* 2004). The fieldwork was carried out in the Kalakad-Mundanthurai Tiger Reserve (KMTR, 895 sq. km, 8° 25' to 8° 53' N, 77° 10' to 77° 35' E) in the Agasthyamalai region at the southern end of the Western Ghats. KMTR ranges between 50 m and 1700 m above msl with rainforest occurring chiefly above 500 m. This reserve along with adjoining areas has one of the largest remaining contiguous tracts (over 400 sq. km) of relatively undisturbed tropical rainforest in the Western Ghats (Ramesh *et al.* 1997). The rainforest vegetation in KMTR has been classified mid-elevation tropical wet evergreen rainforest of the *Cullenia exarillata-Mesua ferrea-Palaquium ellipticum* type (Pascal 1988; Ganesh *et al.* 1996; Parthasarathy 2001). Within the rainforest, the mean monthly daytime temperature ranges between 19 °C in January and 24 °C in April-May (at Sengaltheri, 1040 m, range 15-31 °C). The total rainfall was 2283 mm in 1998 and 2230 mm in 1999 at Sengaltheri. There are three seasons: (a) dry season (February to May), (b) southwest or summer monsoon (June to September), and (c) northeast or winter monsoon (October to January). KMTR receives over half its annual precipitation during the northeast monsoon.

Although 278 bird species have been recorded in and around KMTR, only 84 species occur in rainforests including 12 endemics and 13 winter migrants (Raman 2001). A majority of species breed between late January and May (Ali and Ripley 1983, TRSR pers. obs). The sites chosen for intensive bird community sampling were located at Kannikatti (740 m, 8° 37' N and 77° 16' E), Sengaltheri (1040 m, 8° 31' N and 77° 26 E), and Kakachi (1220 m, 8° 33' N and 77° 24' E) in KMTR. These areas contain rainforests between 500 m and 1400 m altitude, contiguous with rainforests elsewhere in the Reserve. Fourteen sites located along this altitudinal gradient in relatively undisturbed rainforest were selected randomly, within logistical constraints, around three forest camps (four accessed from Kannikatti, six from Sengaltheri, and four from Kakachi) and located on topographic maps using landmarks and a global positioning system receiver (GPS).

Bird surveys

The fixed-radius point count method was used to survey bird populations in each site in a relatively uniform and efficient manner during the main breeding season (Verner 1985; Ralph *et al.* 1995). Point count surveys (5 min duration) were carried out during the first three hours after sunrise (see Raman 2003 for details of field technique). Densities estimated by the fixed radius approach were used as they were highly correlated to variable-radius point count estimates across species (Raman 2003).

Each sampled site represented an area of around 12-15 ha lying at the designated altitude and was surrounded by contiguous rainforests on at least three sides. Within each site a 600-700 m long transect or narrow animal trail was marked at 25 m intervals for the point count surveys. At each site, 25 point count surveys (yielding 167-247 detections and an estimated 334-597 individual birds per site) were carried out, excluding the Kodayar site where only 18 counts were carried out. Sampling of all sites around Sengaltheri and Kakachi was carried out mostly between February and May 1998, during the peak breeding season when resident and migrant birds were present. For reasons of logistics, the four sites around Kannikatti were sampled only in March 1999.

Vegetation sampling

In each of the 14 sites, densities of trees greater than 30 cm girth at breast height (GBH at 1.3 m) were estimated using the point-centred quarter method (PCQ, Krebs 1989). Thirteen PCQ plots, with successive plots spaced 50 m apart, were measured in each site, giving a sample of 52 trees per site. Comparison with two completely enumerated 1 ha plots (>1800 stems each) in Sengaltheri showed that the density estimates from this PCQ sample was <2% different from the

more laborious enumeration. All trees were identified to species, or in a few cases to genus (Gamble and Fischer 1915-1935; Pascal and Ramesh 1997). Distance from plot centre to the middle of the bole and GBH were recorded for each tree. At each of the 13 PCQ plots, 2 m radius plots were laid to enumerate shrubs. In addition, the number of cane plants and the presence or absence of bamboo within 5 m radius was recorded.

Altitude, canopy measures and leaf litter variables were measured at 25 points, evenly spaced 25 m apart, in each site. Canopy height was measured using a rangefinder and percentage canopy cover using a spherical densiometer. Vertical stratification was assessed at these 25 points by noting the presence or absence of foliage in the following height intervals (in metres): 0-1, 1-2, 2-4, 4-8, 8-16, 16-24, 24-32, and >32, directly above and in a 0.5 m radius around each point (Raman *et al.* 1998). Leaf litter depth on the forest floor was measured using a calibrated wooden probe. As ground vegetation and litter were disturbed along trails, the samples were taken 10 m away from trails into the rainforest interior.

Data analysis

The cumulative list of bird species recorded in each site was used as a basic measure of bird species richness. However, because only 18 point counts were sampled at the Kannikatti site, we obtained standardised estimates of bird community parameters for all sites for 17 sampled points. Using the program EstimateS (Colwell 1997), 100 permutations (17 samples without replacement) were performed to estimate the following parameters and their standard deviations: (1) bird species richness, measured as the cumulative number of species; (2) bird abundance, estimated as the number of individual birds/ha; (3) Shannon-Weiner diversity, calculated as $-\Sigma(p_i \ln p_i)$, where p_i is the proportion of the i^{th} species and the summation is across all species in the pooled samples; (4) rarefaction richness, standardising for sampling effort using Coleman rarefaction curves (Colwell 1997); (5) bootstrap species richness, an incidence-based estimator denoted as $S_{boot} = S_{obs} + \Sigma(1 - p_k)^m$, where p_k is the proportion of m samples with species k and the summation is across all S_{obs} species in the pooled samples; and (6) Chao 1 richness, an abundance-based estimator of species richness (see Colwell 1997 for the formula and correct variance estimator of this index).

Smaller scale point richness and abundance estimates were also obtained by averaging across replicate point count surveys in each site. The average number of species, detections, and individuals per point and their standard errors were estimated for all species combined and for resident species alone. For each site, tree density and basal area were calculated using the PCQ method (Krebs 1989). Average values across replicate sampling points in each site were calculated for other vegetation and site variables: shrub, cane, and cardamom densities, leaf litter depth, canopy height and cover, and altitude. Vertical stratification was measured as the average number of strata with foliage across the 25 points sampled in each site. The coefficient of variation of vertical stratification was used as an index of horizontal heterogeneity (following Raman *et al.* 1998). The total number of tree species recorded in the PCQ plots was recorded as a measure of tree species richness. Relationships between bird community and vegetation variables were assessed using Kendall rank correlations (Siegel and Castellan 1988).

Altitudinal range size of each species was estimated as the difference between the maximum and minimum altitude at which the species was recorded in the point count surveys. The altitudinal range midpoint and a weighted range midpoint, estimated using the abundance of each species in each site, were calculated for each species. Similarities in bird community, foliage profile, and tree species composition between sites were computed using the Morisita index that is least sensitive to sample size effects (Wolda 1981; Raman *et al.* 1998). The matrix of pair-wise dissimilarities (100-Morisita index in %) in bird community composition was related to corresponding matrices of similarity/distance in tree species composition, foliage profile, altitude, and geographic distance between sites using Mantel tests (Manly 1994). Geographic distance between sites was measured as the straight-line distance between sampling sites. Statistical significance of Mantel tests was assessed through 10000 random permutations. To examine the independent effects of different variables, partial Mantel tests, derived from the Kendall tau approach, were used (Hemelrijk 1990). The tree and bird community similarity matrices were also used to ordinate study sites using multidimensional scaling (Manly 1994).

We used correlation and regression techniques to assess statistical significance of altitudinal trends. Linear and non-linear (chiefly quadratic) regressions were applied to describe spatial trend data. We also used non-parametric Kendall (*tau*) rank-order correlation coefficients to assess statistical significance (Siegel and Castellan 1988).

Null model analyses

The mid-domain effect (Colwell and Lees 2000) was assessed using the null model of Veech (2000). Species' altitudinal range widths were retained but located randomly on the altitudinal gradient between 500 and 1400 m (divided into 18 zones of 50 m width) in 1000 simulations to obtain an expected species richness curve along this gradient. The observed pattern of species richness was compared to the simulated curve to obtain a mean displacement, D, where $D = (\Sigma d_j)/18$, where d_j is the absolute difference in species

richness between the two curves being compared for each of the 18 zones (Veech 2000). A further 1000 simulations of the data were used to determine the distribution of D values in each run and to assess statistical significance.

Null models were also used to assess the likelihood of obtaining, under the null model assumptions, estimates equivalent to two measures of the average similarity between sites in bird community composition. These measures were: (i) average similarity between all possible pairs of sites (N = 91 comparisons), and (ii) average similarity between successive sites along the altitudinal gradient (N = 13 comparisons). The Jaccard index (Krebs 1989) was used to measure similarity in bird community composition. With the presence-absence matrix of species across sites, five null models were evaluated:

1. Unconstrained model: matrix total constant, row and column totals varied;

2. Saturation model: fixed column totals (species richness at each site);

3. Distribution model: fixed row totals (number of sites each species occurred in);

4. Doubly constrained model: fixed row and column totals by a procedure equivalent to the Knight's tour algorithm (Sanderson 2000);

5. Range-contiguity model: this model simulated, in addition to the distribution constraint, the contiguity of ranges of species along the gradient. Simulations showed that species occurrences were distributed more contiguously along the gradient than expected by random placement ($P < 0.001$). Using the observed occurrences in the species-by-site matrix, the relative probability of occurrence in any one of the 12 intermediate sites (excluding the 2 'edge' sites–the lowest and highest site) was found to be enhanced by a factor of 9.0 if the species also occurred in sites immediately above and below, and by a factor of 4.5 if it occurred only in one adjacent site either above or below. These enhancement factors were in relation to the probability of occurrence in a site when the species was absent from both adjacent sites on the gradient. For the edge sites, occurrence was enhanced by a factor of 3.6 if the species occurred in the adjacent site in relation to occurrence when it was absent in the adjacent site. These were then used to distribute occurrences in simulations to produce probabilistic contiguous distributions.

These models attempt to simulate the effects of chance and biological constraints on the assembly of species communities (Farnsworth and Ellison 1996; Stone *et al.* 1996; Sanderson 2000). In contrast to the unconstrained model, the saturation, distribution, and doubly-constrained models implement constraints on the number of species that can fill each site and simulate the effects of interspecific differences in distribution and occurrence probabilities. Our range-contiguity model incorporates, in addition, constraints on species' altitudinal distributions and contiguity of ranges. We retained in the contiguity model the number of intermediate absences or 'holes' in range but randomised their location. Even with these constraints, we checked and established that over 5000 different matrices existed in simulations. For each of the above models, we simulated 5000 randomised matrices and the averages of the obtained distribution of similarity values (between all possible pairs of sites and adjacent sites) were statistically compared to the observed average similarity values.

RESULTS

Bird species richness, diversity, and abundance

Across the 14 sites, we obtained over 2900 detections comprising approximately 6600 individuals of birds belonging to 67 species. Of these, nine species were latitudinal (winter) migrants and the remaining were resident species. Thirteen species were detected only once and a further seven species were seen less than five times overall. Total bird species richness (cumulative list in each site) was significantly negatively correlated to altitude of the site (Kendall rank-order correlation, $\tau = -0.52$, $n = 14$, $P = 0.01$, Table 1). Resident bird species richness appeared to decline with altitude, but this trend was not significant statistically (P = 0.08). The standardised estimates for 17 point counts obtained over 100 runs (sampling with replacement) of species richness, Shannon-Weiner diversity, Coleman rarefaction richness, bootstrap richness, and the Chao1 richness were all significantly negatively correlated to altitude ($P < 0.05$, Table 1). Most of the decrease occurred between 500 m and 900 m altitude, after which there was little change in species richness. Bird abundance showed a converse positive association with altitude that was marginally significant (τ = 0.39, n = 14, P = 0.055, Table 1). The per point estimates of total and resident bird species richness, detections, and abundance showed significant variation across the 14 sites (one-way ANOVA, $F_{13,329} > 5.58$, $P < 0.004$). Whereas the number of detections per point showed weak negative correlations with altitude ($\tau = -0.41$, $P = 0.04$), the trends for total and resident species richness and detections with altitude were non-significant. Bird abundance per point increased with altitude, weakly and non-significantly in the case of total abundance ($\tau = 0.38$, $P = 0.06$) and significantly in the case of abundance of resident species ($\tau = 0.52$, $P = 0.009$).

Vegetation and birds: correlations

Vegetation variables were not significantly correlated

Table 1: Bird community parameters along an altitudinal gradient in the rainforests of Kalakad-Mundanthurai Tiger Reserve, India, showing Kendall rank-order correlations with altitude

Transect Code	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Correlation with altitude		
Mean altitude (m)	558	646	751	843	900	980	1092	1228	1256	1259	1265	1287	1341	1359	t	Z	P
Cumulative species richness																	
Total species	40	36	36	34	30	29	31	29	32	31	30	25	28	32	-0.520	-2.59	0.0096
Resident species	35	30	30	29	26	25	27	26	30	27	28	25	25	30	-0.352	-1.75	0.0798
Standardised estimates (EstimateS)																	
Bird species richness	36.8	33.0	33.0	31.1	27.4	25.9	28.2	27.0	28.9	27.5	26.3	21.9	27.6	29.97	-0.407	-2.03	0.0428
SD	1.60	1.46	1.60	1.34	1.55	1.99	1.38	1.31	1.37	1.83	1.90	1.72	0.60	1.15			
Bird abundance (individuals/ha)	22.6	24.3	21.7	22.3	23.0	17.0	22.1	29.7	24.8	25.5	20.7	25.2	25.8	30.5	0.385	1.92	0.0554
SD	0.81	1.10	1.20	1.18	1.64	1.51	1.61	1.50	1.63	1.58	1.48	2.15	0.68	1.93			
Shannon-Weiner diversity	3.22	3.03	3.06	3.02	2.73	2.74	2.82	2.69	2.79	2.63	2.48	2.07	2.53	2.8	-0.626	-3.12	0.0018
SD	0.04	0.04	0.05	0.04	0.08	0.08	0.05	0.07	0.06	0.07	0.11	0.09	0.03	0.05			
Coleman rarefaction richness	37.7	34.1	34.2	32.3	28.5	27.8	29.8	28.1	31.4	29.1	27.9	23.4	27.8	31.3	-0.538	-2.68	0.0073
SD	1.29	1.18	1.16	1.14	1.06	0.99	0.96	0.84	0.72	1.23	1.25	1.10	0.41	0.76			
Bootstrap richness	41.1	37.1	37.3	34.3	30.8	29.6	31.5	29.8	32.3	31.2	30.4	25.2	30.5	33.1	-0.429	-2.14	0.0328
SD	2.11	1.92	2.15	1.79	1.98	2.45	1.80	1.71	1.86	2.42	2.46	2.19	0.76	1.42			
Chao1 richness	40.6	33.9	35.1	32.1	28.3	26.2	28.5	27.2	29.0	28.3	28.3	23.6	28.3	30.2	-0.420	-2.09	0.0365
SD	6.31	2.06	4.38	2.08	2.20	0.86	1.19	0.19	0.46	1.60	3.70	4.38	2.08	1.00			

with altitude (Kendall correlations, $P > 0.05$), except for bamboo culm density ($\tau = 0.52, n = 14, P = 0.01$) mainly due to the occurrence of bamboo at only two higher altitude sites. The six standardised estimates of bird species richness, Shannon-Weiner bird diversity, and the per-point total and resident bird species richness were all significantly negatively correlated to one of the vegetation variables: leaf-litter depth ($\tau < -0.45, n = 14, P < 0.03$ in all cases). These variables were also not correlated to any of the other vegetation variables. Bird abundance (standardised and per-point) and the total number of bird detections per point were not correlated to any vegetation variable. The average number of resident bird detections per point was negatively correlated to leaf litter depth ($\tau = -0.47, P = 0.037$).

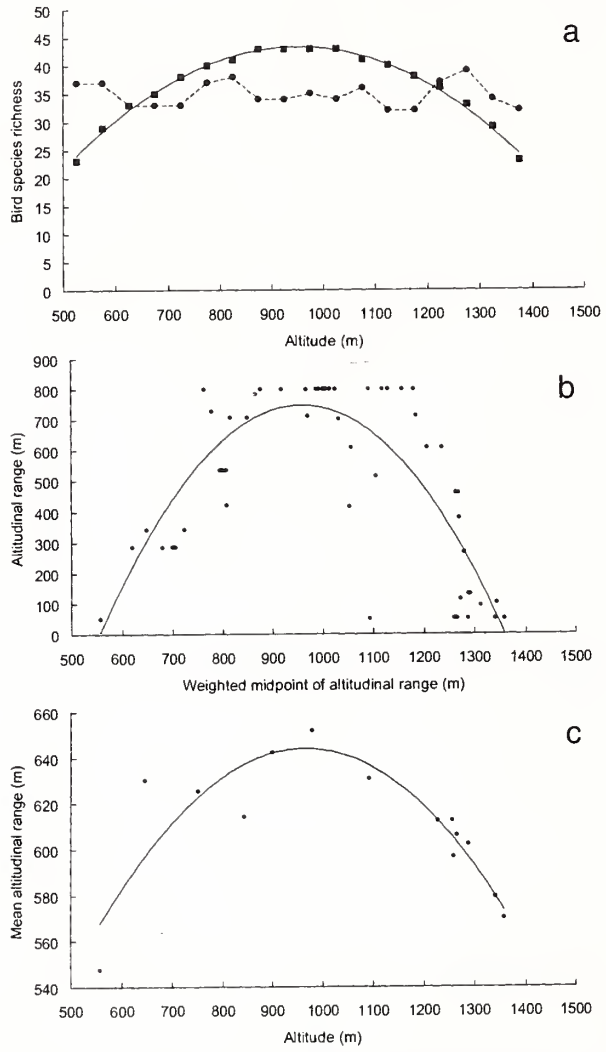

Fig. 1: Bird species richness and range size relationships in rainforests of KMTR; (a) upper panel: evaluation of the Veech (2000) null model of the mid-domain effect—line shows best fit curve to null model estimates against observed curve (dotted line); (b) middle panel: altitudinal range size of 58 resident bird species in relation to the weighted mid-point of their altitudinal range; and (c) lower panel: mean altitudinal range of species at each of the 14 sampled sites in relation to altitude of the sites.

Range distributions, sizes, and species richness

The range size and distribution pattern across the 58 resident bird species varied from species occurring in one to all 14 sites spanning the entire gradient. Twenty-three species (39.7%) were either restricted to lower altitudes or showed declining trends with altitude in population density (Kendall correlations, $P < 0.10$, Appendix). Sixteen species (27.6%) displayed a trend of increase in population density with altitude ($P < 0.10$) or were restricted largely to higher altitude sites (Appendix). Only two species of woodpeckers, *Dinopium javanense* and *Dryocopus javensis*, appeared to be restricted to mid-altitudes. The spatial distributions of the remaining species were widespread and relatively uniform (14 species) or could not be determined due to low sample sizes (3 species).

Across the gradient, the number of resident bird species whose ranges intercepted each 50 m altitude zone was nearly constant at around 35 species (Fig. 1a). This was significantly different from the Veech (2000) null model that predicted a mid-domain peak (Fig. 1a, $d = 6.51, P < 0.001$). The relationship between altitudinal range size of a species and the weighted midpoint of its altitudinal range was also non-linear and quadratic (Fig. 1b, fitted curve: $y = -0.0046\ x^2 + 8.8633\ x - 3496.8$, $R^2 = 0.72$). Similarly, in contrast to the expectation under Rapoport's rule, the mean altitudinal range of species in each site showed a quadratic relationship with the altitude of the site (Fig. 1c, fitted curve: $y = -0.0005\ x^2 + 8.8839\ x + 216.99, R^2 = 0.78$).

Bird species turnover

Species turnover was considerable along the altitudinal gradient. Non-metric multidimensional scaling ordination using the Morisita dissimilarity matrix of the data on tree and bird species composition showed similar patterns (stress = 0.070 and 0.034, Fig. 2a, b, respectively). Sites below 900 m tended to cluster together as did sites above 1100 m, while intermediate sites were relatively dissimilar to the others (with exceptions shown in tree species composition by site D at 843 m and site M at 1341 m).

Partial Mantel tests showed that dissimilarity in bird community composition between sites was independently positively correlated to both altitudinal distance between sites ($T = 0.60, P < 0.0001$, Fig. 3a) and dissimilarity in tree species composition ($T = 0.22, P = 0.013$, Fig. 3b). Correlations with both these variables were significant even when controlled for the effects of geographic distance ($T = 0.69$ and 0.51, $P < 0.0003$). In contrast, geographic distance between sites had no effect on bird species composition, when the effects of

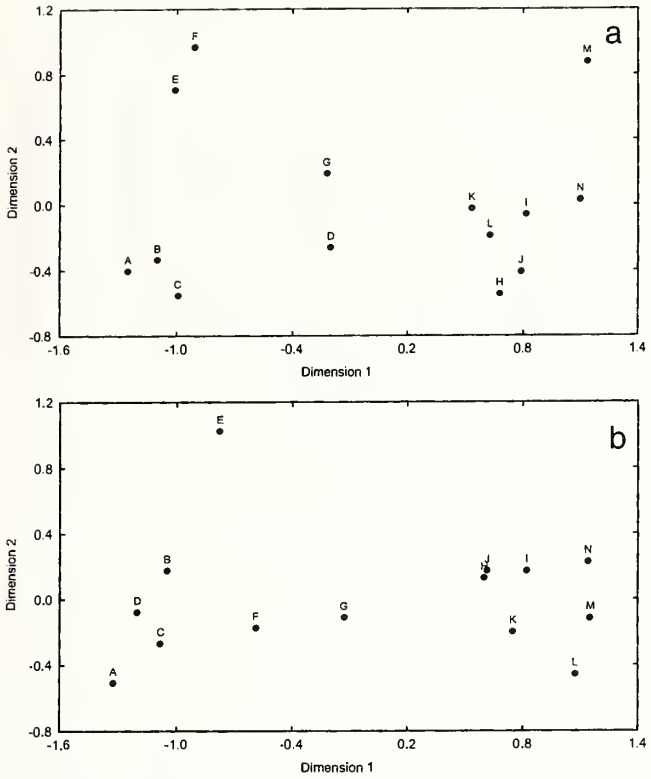

Fig. 2: Ordination of study sites on the basis of similarity in (a) tree species composition (upper panel) and (b) bird community composition (lower panel) using multidimensional scaling. Sites are named A to N in increasing order of altitude.

altitudinal distance were controlled for ($T = 0.08$, $P = 0.12$), indicating the primary importance of altitude. We found no significant effect of foliage profile dissimilarity on bird community composition.

Species turnover between sites (average of 91 all-possible pairs) was 0.529 ±0.139 SD by the Jaccard similarity index and 0.608 ±0.251 SD by the Morisita similarity index. This was lower than average similarity in bird community composition between adjacent sites (Jaccard index: 0.693 ±0.107 SD, Morisita index: 0.860 ± 0.103 SD). The pattern of turnover was not monotonic or increasing with altitude, and remained relatively low but for higher turnover (lower similarity) around 1000 m (Fig. 4).

Null models of species turnover

We assessed whether the five null models of bird species turnover could accurately estimate the observed Jaccard similarity between all possible pairs of sites (0.529 ±0.139 SD) and between adjacent pairs of sites (0.693 ±0.107 SD). The unconstrained model and saturation models gave similar results, producing similarity estimates that were significantly lower than the observed ($P < 0.0002$, Fig. 5). The estimated average similarities between all possible pairs of sites by the range-contiguity model and the double-constraint model were close to that actually observed (0.516 vs. 0.529), but were, nevertheless, significantly lower ($P < 0.0002$). The double-constraint model also performed poorly in estimating average similarity between adjacent sites (0.517 vs. 0.693). The range-contiguity model estimated similarities between adjacent sites that were higher and much closer to the observed value (0.622 vs. 0.693). However, the model estimates were significantly lower than the observed values for double-constraint and range contiguity models ($P < 0.0002$, Fig. 5).

DISCUSSION

Species richness

Species richness of resident rainforest birds varied little despite substantial change in community composition across the altitudinal gradient, in contrast to expectation from the four main models hitherto proposed (Rahbek 1997). The general model, propounding a monotonous decline in species richness with altitude in parallel with an assumed decline in productivity, finds weak support, if any, when all bird species including latitudinal migrants are considered. The pattern of range sizes observed in this study results in local species richness patterns that depart significantly from expectations

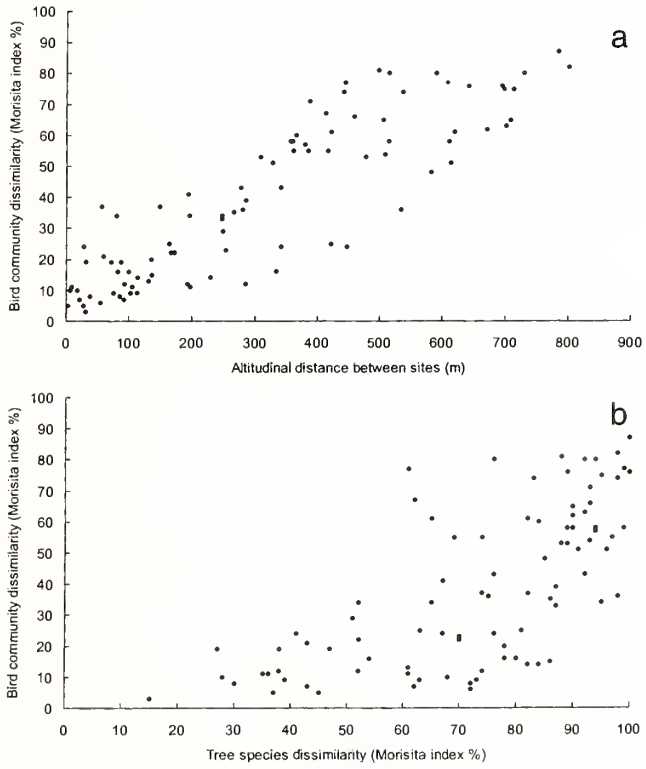

Fig. 3: Bird community dissimilarity between sites (91 all-possible pairs) in relation to corresponding between-site (a) altitudinal distance (upper panel) and (b) tree species dissimilarity (lower panel).

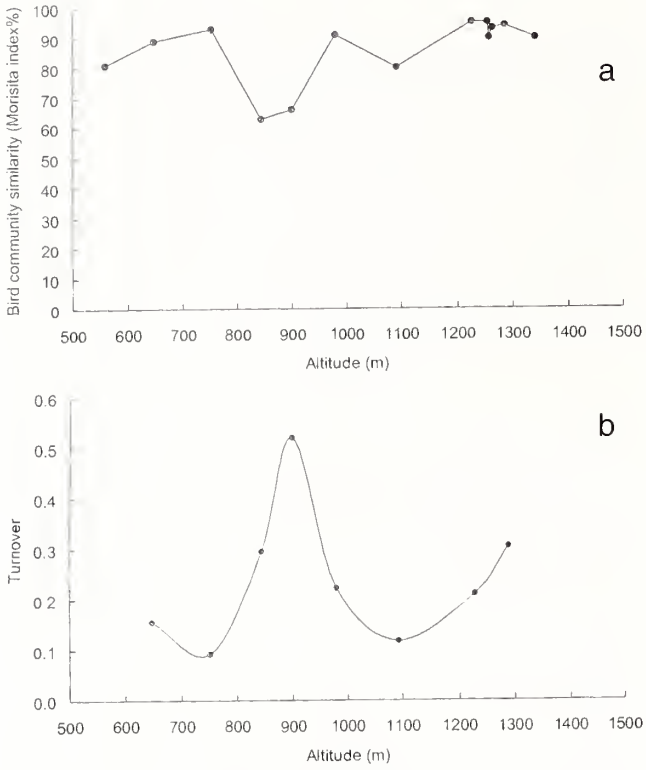

Fig. 4: Turnover in rainforest bird community composition as a function of altitude in KMTR. In the upper panel (a) similarity between each site and the immediately higher site is plotted against altitude of the lower site. The lower panel (b) uses data from 10 roughly equally-spaced sites along the gradient and plots rate of change in similarity between a site and the sites immediately lower and higher to it against altitude of the central site. The rate of change of similarity was calculated as $\frac{1}{2}[(d_1/w_1)+(d_2/w_2)]$, where d_1 and w_1 are the Morisita index dissimilarity and altitudinal distance between a site and the lower site, and d_2 and w_2 the corresponding values for the higher site.

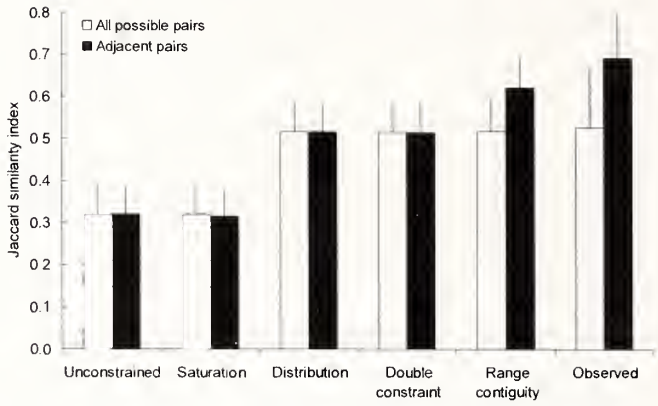

Fig. 5: Between-site similarities (average Jaccard index) in rainforest bird community composition estimated from the five non-equilibrium null models compared with observed values in the data set. Vertical lines are 1 SD.

under Rapoport's rule, hump-shaped relationships with productivity (Rosenzweig and Abramsky 1993), or mid-altitude peaks arising from geometric constraints (the mid-domain effect, Colwell and Lees 2000).

Instead, the observed pattern of bird species richness is a spatial analogue of the recent theoretical model proposed by Brown *et al.* (2001), to explain the regulation of local species richness over time in changing environments. This model suggests that species composition may vary substantially over time, but species richness, as an emergent property of ecosystems, is often regulated within narrow limits. Five conditions are necessary and sufficient for this to occur (Brown *et al.* 2001): (i) productivity, or resource availability, remains relatively constant, (ii) other abiotic or biotic factors vary, causing turnover in species composition, (iii) a regional species pool provides a source of colonists to local sites that are open systems with respect to species colonisation and extinction, (iv) the species pool contains species capable of utilizing the entire range of resources and showing compensatory shifts in abundance, and (v) the division rule governing apportioning of resources across species results in similar ranked species-abundance distributions.

There is partial support for these criteria for rainforest birds in KMTR. Although productivity could not be directly measured, the relative lack of clinal change in vegetation variables across the altitudinal gradient suggests that habitat structure and resource availability did not vary substantially. This is partly because a narrower altitudinal gradient was sampled in this study (500-1400 m) compared to studies from the Neotropics (Terborgh 1971, 1977; Rahbek 1997). Over a wider altitude range, bird diversity may decline with altitude and corresponding reduction in forest structural complexity as in the Peruvian Andes (Terborgh 1977). In the present study, bird species richness variables were uncorrelated to any vegetation variables except for a negative, possibly spurious, correlation with leaf litter depth. The second condition of Brown *et al.* (2001), species turnover due to changes in abiotic and biotic variables, finds clear support in the correlated variation in bird community composition in relation to altitude and tree species composition. The existence of a species pool that is nearly twice as large (with at least 58 species) as in any one local sampling site (around 30 species), adduces support for the third criterion. Finally, the occurrence of a number of species that occurred across the entire altitudinal gradient and the similar overall bird abundance and ranked species-abundance distributions (data not presented here) suggest support for the final criteria. Further support is, however, required regarding compensatory shifts in abundance of bird species along the altitudinal gradient, possibly in relation to occurrence of other bird species (Terborgh and Weske 1975).

Species range sizes and distribution

Range sizes of rainforest birds at KMTR do not conform to the expectations under Rapoport's rule, which may operate only under specific ecological conditions including competition and the rescue effect (Taylor and Gaines 1999). The failure of Rapoport's rule and the mid-domain effect is consequential to the peculiar distribution pattern of rainforest birds in KMTR. A number of species, particularly those endemic to the Western Ghats, were restricted in distribution to lower (e.g., *Ocyceros griseus*, *Cyornis pallipes*) or higher (*Ficedula nigrorufa*, *Brachypteryx major*) altitudes (Appendix, Ali and Ripley 1983). Daniels (1992) has noted that a significant proportion of endemics, among birds and angiosperms in the Western Ghats, is restricted to the higher hills (> 1000 m). In other words, bird distributions were mainly of three types, restricted-range species of low and high altitudes, and widely distributed species, with no mid-altitude species with small ranges. The low altitude species included many that also use moist deciduous forest habitats (e.g., *Ocyceros griseus, Psittacula columboides, Pycnonotus priocephalus*), whereas high-altitude restricted species are largely confined to wet evergreen rainforest (e.g., *Ficedula nigrorufa, Brachypteryx major, Eumyias albicaudata*, Ali and Ripley 1983). This pattern may be a consequence of historical factors that influenced the prevalence and distribution of rainforest over geological time scales.

Species turnover

A spectrum of opinion exists on the factors influencing the composition or assembly of species communities at particular sites and their variation over space and time. At one extreme, equilibrial models suggest that local communities are integrated, repeatable units whose composition is strictly regulated and predictable as a result of deterministic factors such as the varying environmental tolerances of species and competition (Clements 1916; MacArthur 1972; Pandolfi 1996; Terborgh *et al.* 1996; Pitman *et al.* 2001). In contrast, non-equilibrium approaches note that community composition varies substantially over space and time, apparently due to stochastic or historical effects of colonization and extinction (Gleason 1926; Whittaker 1970; Strong *et al.* 1984; Hubbell and Foster 1986; Brown *et al.* 2001). A fundamental distinction between non-equilibrium and equilibrium models is that under the former, community composition may be expected to 'drift' or vary continuously through space and time, whereas the latter predicts that spatially or temporally independent sites with similar environmental conditions would have similar communities (Hubbell and Foster 1986; Terborgh *et al.* 1996). Using a space-for-time substitution approach, biological influences and deterministic structure have been demonstrated for communities of tropical rainforest trees (Terborgh *et al.* 1996; Pitman *et al.* 2001) and birds (Terborgh and Weske 1975; Raman *et al.* 1998).

The significant effect of altitude and tree species composition on bird community composition and the lack of influence of geographic distance, suggests the inapplicability of non-equilibrium models of randomly-varying distribution-abundance patterns with spatial dependence (Terborgh *et al.* 1996). Thus, high-altitude sites in Sengaltheri clustered with high-altitude sites farther away (Neterikal trail, Kakachi and Kodayar) than to virtually adjacent sites at lower altitudes. Bird community composition may be constrained by the altitude-specific environment including temperature, irradiance, and other biological factors known to vary with altitude in tropical rainforests (Richards 1996). In addition, tree species composition appears to be a key determinant of rainforest bird community composition in this study as in other studies from south-western India (Raman and Sukumar 2002), and north-eastern India (Raman *et al.* 1998).

The pattern of species turnover with altitude indicated the occurrence of distinctive community composition at low-altitudes (< 900 m) and high altitudes (> 1100 m) separated by a transitional zone of high turnover. This paralleled the observed range size distributions and placements of rainforest birds in, KMTR. The occurrence of the transition zone at around 1000-1200 m altitude may be due to environmental changes related to the formation of cloud- and mist-cover during the monsoon months in the southern Western Ghats as in other tropical montane rainforest regions (Richards 1996).

Null models of community assembly

In large-scale community studies, models with few or no constraints that attempt to parsimoniously simulate the effects of pure chance, almost invariably fail to explain community structure (Farnsworth and Ellison 1996; Terborgh *et al.* 1996; Pitman *et al.* 2001). In this study, we evaluated a hierarchy of null models with constraints that attempt to inject varying degrees of biological realism. The results clearly indicate that non-equilibrium models that do not incorporate essential biological constraints fail to predict or reproduce the observed pattern of similarities in species composition between sites. Even with constraints on site richness, species' range widths, and contiguity, the results suggest that assuming species are distributed independently of each other can result in community similarities close to, but departing significantly from, those actually observed. Thus, Whittaker's (1970) models of local community structure as a consequence of independent overlapping species distributions along ecological gradients are only partly supported. The data suggests the possibility that some species have significantly

higher overlap or avoidance due to biological determinants such as joint distributions up to ecotones or exclusive distributions due to competitive interactions (Terborgh 1971, 1985). Field research in the Western Ghats on competition and on avian distributional ecology along with null model tests (e.g. Hofer *et al.* 1999, 2000) may shed more light on these aspects.

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Appendix: Range distribution and abundance (individuals/ha) of resident rainforest bird species in KMTR. Species are arranged increasing order of elevational mid-point. Rank refers to increasing correlation (Kendall Tau) between site elevation and abundance across sites A to N (see Table 1).

Scientific name	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Tau	P	Rank
Tephrodornis gularis	0.1														-0.38	0.060	17
*Pycnonotus priocephalus**	0.1														-0.38	0.060	18
Nectarinia lotenia	0.1														-0.38	0.060	19
Psittacula cyanocephala	0.1														-0.38	0.060	20
*Turdoides subrufus**	0.2														-0.38	0.060	21
Megalaima rubricapilla	0.2	0.1		0.1											-0.58	0.004	10
Gracula religiosa	0.5	0.3	0.1	0.6											-0.62	0.002	6
*Ocyceros griseus**	0.6	0.2	0.2	0.4											-0.62	0.002	7
Dicrurus aeneus	0.1			0.1											-0.43	0.033	15
Pycnonotus melanicterus	0.7	0.1		0.3	0.5										-0.56	0.006	12
Chloropsis aurifrons	0.3	0.1	0.1		0.1										-0.64	0.001	4
Dendrocitta leucogastra	0.6	0.6	0.5	1.8	0.8	0.7									-0.59	0.004	9
Irena puella	1.0	1.1	0.5	0.9	0.6	0.8	0.8								-0.69	0.001	3
*Psittacula columboides**	0.8	0.5	0.3	0.8	0.2	0.2	0.6								-0.71	0.000	1
Hypothymis azurea	0.3	0.3	0.4	0.4	0.9		0.1								-0.58	0.004	11
Celeus brachyurus	0.1				0.1	0.2	0.1	0.1	0.1	0.1					-0.21	0.291	28
Accipiter virgatus	0.2	0.1	0.1				0.1				0.1				-0.45	0.026	14
Dicrurus paradiseus	2.0	1.1	1.1	1.2	1.1	0.4	0.5	0.4	0.2	0.7	0.5				-0.70	0.000	2
Loriculus vernalis	0.8	0.4		0.1		0.4	0.3		0.1		0.1	0.1			-0.43	0.034	16
*Cyornis pallipes**	1.1	0.7	0.7	1.1	0.8	1.1	0.3		0.1		0.4	0.2	0.1		-0.53	0.009	13
Chrysocolaptes lucidus	0.7	0.5	0.7	0.3	0.1		0.2	0.5	0.3	0.1	0.4	0.4	0.3	0.3	-0.23	0.254	27
Ducula badia	0.8	1.5	1.5	1.3	0.3	0.1	0.2							0.2	-0.63	0.002	5
Gallus sonneratii	0.5	0.2	0.7	0.6	0.4	0.1	0.1	0.2	0.3	0.1				0.1	-0.62	0.002	8
*Nectarinia minima**	3.1	2.8	3.2	3.3	3.0	2.7	2.9	3.2	1.2	2.8	2.9	3.1	0.4	1.2	-0.37	0.065	22
Harpactes fasciatus	0.3	0.5	0.3		0.2	0.2		0.3	0.2	0.1	0.2		0.1	0.2	-0.35	0.080	23
Pellorneum ruficeps	0.4	0.5	0.8	0.9	0.3	0.5	0.3	0.4	0.9	0.2	0.5	0.2	0.4	0.3	-0.28	0.162	24
Megalaima viridis	0.5	1.0	0.3	0.7	0.1	0.4	1.2				0.1	0.1	0.3	0.3	-0.27	0.171	25
Iole indica	1.3	2.1	2.3	1.8	2.3	2.4	2.8	1.0	0.6	0.6	1.1	1.6	1.1	1.1	-0.26	0.203	26
Pericrocotus flammeus	0.9	0.4	0.7	0.1	0.4	0.8	1.0	0.2	0.4		0.2	0.3	0.5	0.7	-0.12	0.543	29
Sitta frontalis	0.5	0.8	0.2	0.3	0.5			0.3	0.3	0.1	0.3	0.2	0.4	0.8	-0.02	0.910	33
Alcippe poioicephala	1.0	3.3	1.7	2.0	2.0	2.3	2.7	4.3	3.5	4.0	1.8	1.9	3.0	1.4	0.12	0.547	36
Myophonus horsfieldii	0.4	0.3	0.4	0.4	0.1	0.2	0.2	0.8	0.3	0.5	0.4	1.1	0.4	0.4	0.24	0.240	39
Spilornis cheela												0.1			0.26	0.192	40
Dicaeum concolor	0.1	0.3	0.5	0.4	0.3	0.3	1.0	0.6	0.4	0.3	0.1	0.6	0.7	0.9	0.33	0.104	42

Appendix (*contd.*): Range distribution and abundance (individuals/ha) of resident rainforest bird species in KMTR. Species are arranged increasing order of elevational mid-point. Rank refers to increasing correlation (Kendall Tau) between site elevation and abundance across sites A to N (see Table 1).

Scientific name	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Tau	P	Rank
Arachnothera longirostra	0.1	0.2	0.2	0.2			0.3	0.9	0.4	0.7	0.2	0.5	0.4	0.5	0.46	0.023	49
Pomatorhinus horsfieldii	0.3	0.1	0.3	0.4	0.9	0.6	0.6	1.2	1.1	0.9	0.8	0.4	1.1	1.1	0.49	0.014	50
*Garullax delesserti**		1.4			5.0			0.8	0.8					1.0	-0.03	0.887	32
Dinopium javanense			0.1	0.1		0.1		0.1	0.2	0.1	0.1				-0.01	0.944	34
Dryocopus javensis				0.1						0.1					-0.04	0.831	30
Galloperdix spadicea (a)							0.1								-0.03	0.885	31
Rhopocichla atriceps		0.1	0.5				0.2		0.5	0.8	0.4	0.2	0.4	0.4	0.35	0.080	43
Chalcophaps indica			0.1			0.1		0.2	0.2	0.1		0.1	0.1	0.1	0.36	0.072	45
Lonchura kelaarti			0.2											0.2	0.09	0.670	35
Zoothera citrina			0.1	0.1		0.1		0.2	0.2	0.4	0.4	0.1	0.1	0.2	0.55	0.006	53
Hypsipetes leucocephalus					0.2	0.1	0.6	0.7	1.8	1.7	0.2	0.7	1.3	1.1	0.66	0.001	56
Zosterops palpebrosus					0.8	1.2	3.1	6.1	5.7	5.0	6.2	11	8.9	7.6	0.83	0.000	58
Hemipus picatus						0.2	0.2	0.5	0.2	0.5	0.2	0.2	0.4	0.8	0.70	0.000	57
Turdus merula (b)										0.1					0.15	0.469	37
Culicicapa ceylonensis							0.4	3.0	1.8	2.6	2.2	1.8	1.8	2.8	0.64	0.001	55
Ceyx erithacus (c)											0.1				0.20	0.311	38
Parus xanthogenys								0.1	0.2	0.4	0.1	0.3	0.1		0.51	0.012	51
*Eumyias albicaudata**								1.2	0.8	0.4		0.1	0.6	1.1	0.52	0.010	52
*Ficedula nigrorufa**								1.8	1.2	1.9	0.8	0.2	1.4	2.5	0.63	0.002	54
*Garrulax jerdoni**									0.4					2.2	0.36	0.076	44
Picumnus innominatus											0.1			0.1	0.43	0.033	48
Pycnonotus jocosus (d)													0.3		0.32	0.111	41
Gorsachius melanolophus														0.1	0.38	0.060	46
*Brachypteryx major**														0.3	0.38	0.060	47

*Species endemic to Western Ghats. **Incomplete data:** (a) also occurs sporadically in elevations below site G, more infrequently above, (b) also occurs in higher elevation sites, (c) vagrant, seen only once during the study, (d) a non-forest species, occurring at the rainforest edge only in the slightly disturbed site M.

STATUS AND DISTRIBUTION OF A NEWLY DOCUMENTED RESIDENTIAL GANGETIC DOLPHIN (*PLATANISTA GANGETICA* ROXBURGH 1801) POPULATION IN EASTERN ASSAM[1]

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Among the four freshwater species of dolphin, the Gangetic Dolphin (*Platanista gangetica*) is found in the Ganga and Brahmaputra drainage systems of India. At present, *P. gangetica* is considered a highly endangered mammal in India and is strictly protected under the Wildlife (Protection) Act, 1972 as a Schedule I species. This species was once common in the Brahmaputra river system, but due to various natural and anthropogenic pressures, its population is decreasing rapidly, resulting in the disappearance of most of the residential dolphin populations, especially from eastern Assam. In this critical situation, a residential dolphin population has recently been identified downstream of Lohit river. An extensive effort has been made to investigate the population status and distribution pattern of this dolphin population. The present communication is a result of that effort.

Key words: *Platanista gangetica*, status, distribution, population, Brahmaputra, conservation

INTRODUCTION

There are only four species of freshwater dolphins in the world. Among them, Buoto (*Inia geoffrensis*) is found in South America, Baiji (*Lipotes vexillifer*) in the Yangtze river system of China, Bhulan (*Platanista minor*) in Pakistan and Gangetic Dolphin (*Platanista gangetica*) in the Ganga-Brahmaputra-Meghna and Karnapuli river systems of India, Bangladesh and Nepal (Anderson 1878; Kasua and Haque 1972; Jones 1982; Mohan 1989; Reeves and Brownell 1989; Shrestha 1989; Reeves *et al.* 1993).

The distributional range and numbers of the Gangetic Dolphin have been declining in many areas (Reeves and Leatherwood 1995) and the IUCN revised its threatened status from Vulnerable (Klinowska 1991) to Endangered (IUCN 1996).

Some studies have been undertaken to determine the status and distribution of *Platanista gangetica* in Brahmaputra river (Biswas *et al.* 1997; Mohan *et al.* 1997; Biswas and Baruah 2000). But information on its conservation status in the tributaries of Brahmaputra is very poor. No intensive study has been undertaken in these tributaries (which once provided good habitats for the Gangetic Dolphin), except Mohan *et al.* (1998) on the Kulsi river of middle Assam. During our study, we investigated new dolphin habitats in a few tributaries in eastern Assam, and found that a dolphin population exists downstream of Lohit river throughout the year. An effort has been made to determine the status and distribution of this population.

STUDY AREA

The study was carried out in 2000-2002, downstream of Lohit river, which originates from the Yoku peak (6,614 m above msl) of China (Sarma 1993). After flowing *c.* 350 km, Lohit enters Assam (Sarma 1993) and becomes an important tributary of River Brahmaputra. River Lohit started changing channels due to frequent floods in the Dibang river, another major tributary of River Brahmaputra, in 1985-1986; within ten years, by 1995-96, the Lohit started flowing down from Saikhowaghat, through the southern boundary of the Dibru-Saikhowa National Park, engulfing Dangori and Dibru rivers, finally joining Brahmaputra at Balijan.

The study was carried out downstream of Lohit river from Saikhowaghat (27° 47' N, 95° 40' E) to Balijan (27° 34' N, 95° 10' E), a stretch of 60 km (Fig. 1).

METHODOLOGY

At the beginning of this study, we collected secondary information on the dolphin's existence (throughout the year), in the major tributaries of River Brahmaputra in eastern Assam. We targeted the local fishermen and villagers for this information. The information so collected revealed the existence of dolphins downstream of Lohit River throughout the year.

Surveys were conducted upstream and downstream of the River on a country boat, with local boatmen as field guides. I covered 20 km of the river in a single day during the downstream journey and 15 km during the upstream journey, spending maximum time in dolphin surfacing areas. The survey took three days for downstream and four days for upstream observations. A direct-count method (Perrin and Brownell 1989) was followed during the survey. After confirming the existence of dolphins, one continuous survey was made from upstream to downstream and vice versa in a motorboat of low sound emission, at an optimum speed (8-9 km/hr). During this survey, three observers sat at the front of the boat. One was a secondary observer and the data collector, while the other

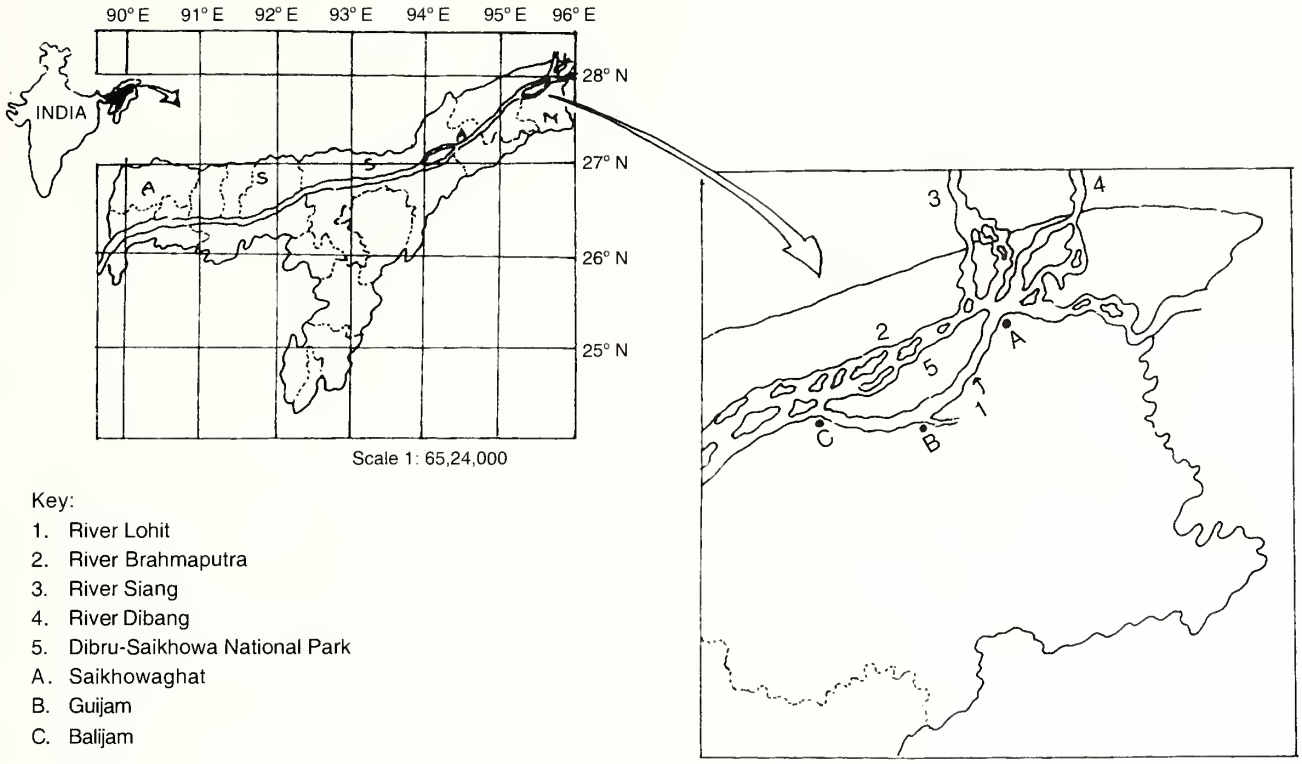

Fig. 1: Map showing the location of Lohit River

two, on either side of him, were primary observers. The maximum, minimum and best count method was followed for a fairly accurate estimation of the population. Maximum and minimum counts indicate the maximum and minimum possibilities of dolphin occurrence in a particular river stretch, while the best counts indicate the optimum occurrence of dolphins. A standard datasheet was used to record the dolphin sightings, habitat status and anthropogenic pressures. A GPS instrument was used at one kilometre intervals to collect data on coordinates. Altogether five surveys (three by row boat and two by motor boat) were made within the study period in the Lohit river.

RESULTS

Population status and distribution of dolphins in Lohit river

During this two year survey, altogether 14 (maximum 16, minimum 13, best 14) dolphins (group size 1-3) were observed in the stretch of River Lohit from Saikhowaghat to Balijan. These dolphins were observed at different locations as different groups in the Lohit river (Table 1), identified only in the winter. During summer, especially during the high flood season, the groups were hardly observed in these locations; most of them were traced in the streams of the Dibru-Saikhowa National Park, which join the Lohit river.

The encounter rate of dolphins in Lohit river was estimated to be 0.23 individuals per km. However, differences in density and distribution were observed in different stretches of the Lohit river. The encounter rate was higher (0.26 individual per km) between Saikhowa and Guijan (27° 34' N, 95° 19' E) than between Guijan and Balijan (0.16 individual per km). Guijan was found to be a demarcating line between these two river stretches, as there was frequent motorboat crossing here (two motor boats per hour). While determining the rate of anthropogenic disturbances, it was found that the Lohit river between Saikhowa and Guijan had less fishing activity (2.14 gill nets per km) than between Guijan and Balijan (5.22 gill nets per km). Also, the intensity of traffic between Saikhowa and Guijan (0.07 motorboat per km) was less than between Guijan and Balijan (0.55 motorboats per km).

Age group

During the study period, one calf each was observed in Dighaltarang and Memdubi. Three subadults were observed, one each in Hatighuli, Memdubi and Balijan. Altogether nine adults were observed in the entire stretch, one each in Hatighuli, Laina and Memdubi, and two each in Doijan, Balijan and Dighaltarang (Table 1). The age class analysis of the dolphins of Lohit river is presented in Fig. 2.

Habitat use

During the survey period, the dolphins were observed in different habitats. Most of the dolphins (43%) were seen in the river confluences (Memdubi and Balijan), followed by

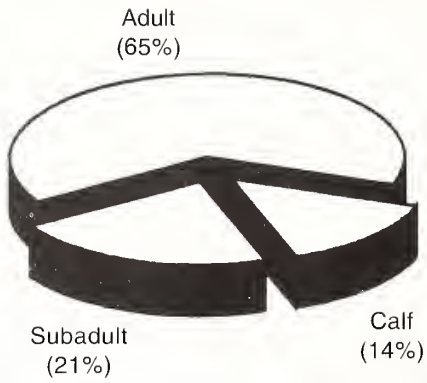

Fig. 2: Age class analysis of dolphins in Lohit River

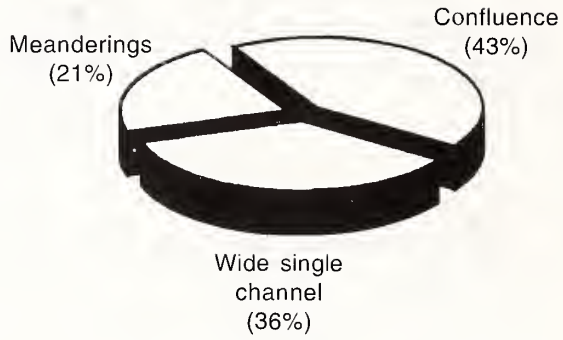

Fig. 3: Habitat use by the dolphins in Lohit River

wide single channel (> 300 m) in the Lohit river. The results are presented in Fig. 3.

DISCUSSION

The distribution of dolphins in Lohit river is seasonal. During the investigations, the above mentioned dolphin groups in Lohit river were seen only during winter (November-March). From April, monsoon precipitation leads to an increase in the water level of Lohit river. As a result, the dolphins are found scattered in the river. During July-August, the area experiences high flooding due to heavy rainfall. At that time, the dolphins migrate locally to the perennial streams (Kolomi, Ajuka, Hamukjan, Laikajan, Dodhiajan etc.), seasonal streams (Garamjan, Erasuti etc.) and wetlands (Tarali, Sal, Burhibeel etc.) of the Dibru-Saikhowa National Park, as well as to other parts of the Lohit river. From the last week of September, the water level in these water bodies starts shrinking, and by October the Lohit river and the locations mentioned on Lohit river (Table 1), are the only deep water bodies in the area. These become the ultimate shelter for the dolphins of Lohit river.

An interesting aspect of this dolphin population is that they are comparatively newcomers to this stretch of Lohit river. Before 1995-96, they were commonly seen in this area during high flood season. At that time, they migrated during flood seasons from the Brahmaputra river to the Dangori river which would have high levels of water owing to flood. But due to changing of channels, the Lohit River started flowing through the Ananta nallah and Dangori river. This resulted in the widening of Dangori and Dibru rivers at least three times (pers. comm., local villagers). The seasonally sighted dolphins started to live in that stretch of Lohit river from 1995-96 and in the last seven years they have become residents.

Table 1: Distribution of dolphins in Lohit river

Sighting area	Sighting location	No. of dolphins		
		Max.	Min.	Best
Hatighuli	27° 45' N, 95° 33' E	2	2	2
Laina	27° 41' N, 95° 30' E	1	1	1
Doijan	27° 39' N, 95° 26' E	3	2	2
Dighaltarang	27° 36' N, 95° 24' E	3	3	3
Memdubi	27° 34' N, 95° 20' E	4	3	3
Balijan	27° 34' N, 95° 11' E	3	2	3
Total		16	13	14

The dolphin population of Lohit river is now facing serious problems, the major threat being fishing. About thirty fringe villages with a population of 25,000-30,000 live on the left bank of the Lohit river. Of these, about 30% are dependent on fishing, and for them this stretch of Lohit river is an important fishing ground. These fishermen employ different fishing gear in the river, including the most dangerous gill-net fishing. During the study period, an average of 2.9 gill-net fishing per km was observed. This heavy fishing leads to accidental dolphin killing. In the last two years, there were four dolphin deaths in the river, of which three were accidental from gill-net fishing. On the other hand, round-the-clock fishing and fish poisoning (especially in the Taralimukh area) are also serious threats to the food sources of these dolphins.

Though dolphin poaching is not so prominent in this river stretch, one dolphin was killed in the Dighaltarang area in November, 2001.

CONCLUSION

At present, the status of freshwater dolphin in India has been considered critical due to a steep decrease in their population; hence they are protected under the Wildlife (Protection) Act, 1972 as a Schedule I species. Protection of the dolphin population of Lohit river should be the topmost

priority of concerned management bodies, as well as locals for ecological equilibrium of the region. For effective conservation, the following measures are suggested, based on my experience in this region.

a. Fishing control: Use of small mesh cast nets, gill nets, using of pesticides and round-the-clock fishing should be strictly banned in the Lohit river.
b. Fishing free zone: Hatighuli, Laina, Doijan, Dighaltarang, Memdubi and Balijan should be declared fishing free zones, especially in the winter.
c. Traditional fishing: The fishermen should be encouraged to use traditional fishing practices, like Jheng fishing in the river stretch from Saikhowa to Balijan of Lohit river for sustainable development of fishery resources for the local communities and the dolphins.
d. Eco-tourism: As an alternate livelihood for fishermen, eco-tourism (river dolphin viewing) can be encouraged in Lohit. This will definitely improve the socio-economic conditions of the fringe villagers and encourage them to participate actively in dolphin conservation.
e. Awareness programme: A long-term and continuous awareness programme for dolphin conservation is the top-most priority in all the fringe villages of Lohit river, without which one can only expect a bleak future for this dolphin population.

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I sincerely thank Dr. S.P. Biswas of Dibrugarh University and Prof. R.K. Sinha of Patna University for their valuable guidance and encouragement for completing this work. I also thank Mr. J. Abedin, Mr. S. Das and the D.F.O., Range Officers and staff of Tinsukia Wildlife Division for their cooperation in fieldwork.

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A TAXONOMIC STUDY OF THE GENUS *PEALIUS* QUAINTANCE & BAKER (HOMOPTERA: ALEYRODIDAE) IN INDIA[1]

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Martin (1999) concluded that *Odontaleyrodes* Takahashi was a junior synonym of *Pealius* Quaintance & Baker. Therefore, detailed study was undertaken on the type specimens of the Indian species of *Pealius* and *Odontaleyrodes*. The study confirmed the observation of Martin (1999) that the two genera are congeneric. Hence, *O. indicus* David, *O. elongatus* David *et al.*, *O. nilgiriensis* David, *O. sairandhryensis* Meganathan & David and *O. splendens* David *et al.* are assigned to the genus *Pealius* Quaintance & Baker. Further, examination of the type specimens of *O. artocarpi* (David *et al.*), *O. selvakumarani* (David *et al.*) and *Pealius nagerkoilensis* Jesudasan & David revealed that they are identical in their taxonomic characteristic features; it was concluded that these species are synonymous. In the light of these findings, a revised key to the genus *Pealius* has been provided.

Key words: Whiteflies, Aleyrodidae, Homoptera, *Pealius*, *Odontaleyrodes*

INTRODUCTION

Quaintance and Baker (1914) erected the genus *Pealius* for *Aleyrodes maskelli* Bemis. Takahashi (1954) erected the genus *Odontaleyrodes* for two species of *Pealius* namely *P. akebiae* (Kuwana) and *P. rhododendri* Takahashi from Japan. Martin (1999) synonymised *Odontaleyrodes* with *Pealius*. Hence, detailed study was undertaken on the type specimens of the Indian species of *Pealius* and *Odontaleyrodes*. The study confirmed the observation of Martin (1999) that the two genera are congeneric. Further, the study resulted in synonymisation of 2 species of *Odontaleyrodes* with *Pealius* and 5 new combinations. The details are as follows:

1. ***Pealius azaleae*** (Baker & Moles)

Aleyrodes azaleae Baker & Moles 1920: *Proc. Ent. Soc. Washington 22*: 81-83.

Pealius azaleae (Baker & Moles) Takahashi 1954: *Insecta Matsumurana 18*: 50.

Neopealius nilgiriensis David & Subramaniam 1976: *Rec. zool. Surv. India 70*: 204-205.

Neopealius nilgiriensis (David & Subramaniam), Martin 1999: *CSIRO Entomology Technical Paper 38*: 92. (Synonymised by Martin 1999).

David and Subramaniam (1976) described a new species *Neopealius nilgiriensis* which was synonymised with *Pealius azaleae* (Baker & Moles) by Martin (1999).

Distribution: INDIA: Tamil Nadu: Ootacamund (The Nilgiris) (David and Subramaniam 1976).

Host Plant: *Azalea indica* (David and Subramaniam 1976).

Material examined: Holotype puparium, India: Tamil Nadu: Ootacamund, *Neopealius nilgiriensis* on *Azalea indica*, 3.vii.1969, B.V. David (loaned by Prof. B.V. David).

2. ***Pealius elongatus*** (David, Sundararaj & Regu) comb. nov.

Odontaleyrodes elongatus David *et al.* 1991. *J. Insect. Sci. 4(2)*: 117-119.

David *et al.*(1991) provided a detailed description of the species.

Distribution: INDIA: Tamil Nadu: Kunnathoor (David *et al.* 1991).

Host Plant: *Ailanthus excelsa* (David *et al.* 1991).

Material examined: Holotype puparium, India: Tamil Nadu: Kunnathoor, *Odontaleyrodes elongatus* on *Ailanthus excelsa*, 25.i.1989, K. Regu (loaned by Prof. B.V. David).

3. ***Pealius indicus*** (David) comb. nov.

Odontaleyrodes indicus David 1972: *Oriental Ins. 6(3)*: 309.

David (1972) gave adequate description of the species.

Distribution: INDIA: Karnataka: Saklespur (David 1972).

Host Plant: Unidentified shrub.

Material examined: Holotype puparium, India: Karnataka: Saklespur, on unidentified shrub, 12.viii.1971, B.V. David (loaned by Prof. B.V. David).

4. ***Pealius nagerkoilensis*** Jesudasan & David

Pealius nagerkoilensis Jesudasan & David 1991: *Oriental Ins. 25*: 320.

Odontaleyrodes artocarpi David, Sundararaj & Regu 1991 syn. nov. *J. Insect Sci. 4(2)*: 117-119.

Odontaleyrodes selvakumarani David, Sundararaj & Regu 1991 syn. nov. *J. Insect Sci. 4(2)*: 117-119.

The examination of the holotypes of *Odontaleyrodes artocarpi* David *et al.*, *O. selvakumarani* David *et al.* and *Pealius nagerkoilensis* Jesudasan & David revealed that they are identical in their taxonomic characteristic features and concluded that these species are synonymous. Therefore, *O. artocarpi* (David *et al.*), *O. selvakumarani* (David *et al.*) are proposed as junior synonyms of *P. nagerkoilensis* Jesudasan & David.

Distribution: INDIA: Tamil Nadu: Kunnathoor, Madurai (David *et al.* 1991); Nagercoil (Jesudasan & David 1991); Kotagiri, Elaimalai, Jamunamarathur hills; Karnataka: Kudremukh National Park, Tal Cauvery (new distribution records).

Host Plants: *Artocarpus hirsutus*, *A. incisa*, *Chickrassia velutina* (David *et al.* 1991); *Loranthus* sp. (Jesudasan and David 1991); *Ageratum conyzoides*, *Butea monosperma*, *Cestrum aurantiacum*, *Derris* sp., *Osbeckia reticulata*, *Gnidia glauca*, *Madhuca neriifolia*, *Salvia splendens* (new host records).

Material examined: India: Tamil Nadu: Nagercoil, Holotype puparium, *Pealius nagerkoilensis* on *Loranthus* sp., 27.xii.1985, Augustine; Kunnathoor, Holotype puparium, *Odontaleyrodes artocarpi* on *Artocarpus hirsutus*, 16.vi.1989, K. Regu; Cumbum, Holotype puparium, *Odontaleyrodes selvakumarani*, on *Chickrassia velutina*, 7.iv.1988, S. Selvakumaran (all loaned by Prof. B.V. David); Karnataka: Kudremukh National Park, 2 puparia, on *Madhuca neriifolia*, 12.viii.2001, A.K. Dubey; Kudremukh National Park, 2 puparia, on unidentified plant, 8.viii.2001, A.K. Dubey; Tal Cauvery, 2 puparia, on *Butea monosperma*, 24.iii.2001, A.K. Dubey; Kemmangundi, 5 puparia, on *Gnidia gluca*, 1.i.2001, A.K. Dubey; Tamil Nadu: Elaimalai, 1 puparium on unidentified plant, 17.iii.2001, A.K. Dubey; 2 puparia, on *Ageratum conyzoides*, Kotagiri, 10.iii.2001, A.K. Dubey; Kodaikanal, 3 puparia, on *Osbeckia reticulata*, 13.iii.2001, A.K. Dubey; Ootacamund, 4 puparia, on *Cestrum aurantiacum*, 9.iii.2001, A.K. Dubey; 1 puparium, on *Salvia splendens*, Kotagiri, 10.iii.2001, A.K. Dubey; Jamunamarathur hills, 2 puparia, on unidentified plant, 19.iii.2001, A.K. Dubey.

5. ***Pealius nilgiriensis*** (David) comb. nov.

Odontaleyrodes nilgiriensis David 1972 : *Oriental Ins. 6(3)*: 309-312.

The description by David (1972) is adequate and no further description is necessary.

Distribution: INDIA: Tamil Nadu: Ootacamund (The Nilgiris) (David 1972).

Host Plant: Unidentified twiner (David 1972).

Material examined: India: Tamil Nadu: Ootacamund (The Nilgiris), Holotype puparium, on unidentified twiner, 3.viii.1969, B.V. David (loaned by Prof. B.V. David).

6. ***Pealius sairandhryensis*** (Meganathan & David) comb. nov.

Odontaleyrodes sairandhryensis Meganathan & David 1994: *FIPPAT Entomology Series 5*: 47.

The description provided by Meganathan and David (1994) is adequate.

Distribution: INDIA: Kerala: Silent Valley (Meganathan & David 1994).

Host Plant: *Oreocnida integrifolia* (Meganathan & David 1994).

Material examined: India: Kerala: Silent Valley, Holotype puparium, on *Oreocnida integrifolia*, 2.ii.1991, P. Meganathan.

7. ***Pealius simplex*** (Singh)

Aleurocanthus simplex Singh 1931: *Mem. Dept. Agric. India 12(1)*: 69.

Dialeurodes glomerata Singh 1931: *Mem. Dept. Agric. India 12(1)*: 39. (Synonymised by Jesudasan & David 1991).

Pealius indicus David & Subramaniam 1976: *Rec. zool. Surv. India 70*: 206. (Synonymised by Jesudasan & David).

Detailed descriptions were provided by Singh (1931); David and Subramaniam (1976), and Jesudasan and David (1991); no additional description is needed, as the information provided by them is adequate.

Distribution: INDIA: Bihar (Pusa) (Singh 1931); Tamil Nadu: Coimbatore, Ootacamund (the Nilgiris) (David and Subramaniam 1976); Padappai (Jesudasan and David 1991).

Host Plants: *Ficus bengalensis*, *F. glomerata* (Singh 1931), *Azalea indica* (David and Subramaniam 1976).

Material examined: India: Karnataka: Kudremukh National Park, 10 puparia, on unidentified shrub, 12.viii.2001, A.K. Dubey.

Comments: The puparium collected from the upper surface of leaves were larger in size; margin smooth and subdorsum with minute setae. The puparium from the lower surface of leaves were rather small; margin deflexed at several places and subdorsum with long setae. The nature of leaf surface is apparently responsible for this kind of morphological diversity. Similar observations were also recorded in *P. simplex* by David and Subramaniam (1976), and Jesudasan and David (1991).

8. ***Pealius spina*** (Singh)

Dialeurodes spina Singh 1931: *Mem. Dept. Agric. India 12(1)*: 27.

Aleuroplatus spinus Takahashi 1952: *Mushi 24*: 23.

Pealius spina David and Subramaniam 1976: *Rec. zool. Surv. India 70*: 209.

The description of the species by Singh (1931), Takahashi (1952), and David and Subramaniam (1976) are adequate and no further addition is necessary.

Distribution: INDIA: Bihar: Mirpur Khas, Daulatpur (Singh 1931); Tamil Nadu: Salem (David and Subramaniam 1976); Padappai (Jesudasan and David 1991); Kerala: Kozhikode (new distribution record).

Host Plants: *Ficus religiosa* (Singh 1931); *F. arnotiana* (new host record).

Material examined: India: Kerala: Kozhikode, 3 puparium on *Ficus religiosa,* 17.iii.2002, A.K. Dubey; Kozhikode, 10 puparia, on *Ficus arnotiana,* 10.iii.2001, K. Regu.

9. ***Pealius spinosus*** Jesudasan & David

Pealius spinosus Jesudasan & David 1991: *Oriental Ins. 25*: 322-323.

Jesudasan and David (1991) provided a detailed description of the species.

Distribution: INDIA: Tamil Nadu: Erode (Jesudasan and David 1991); Karnataka: Yellapur (new distribution record).

Host Plant: Unidentified tree.

Material examined: India: Tamil Nadu: Erode, Holotype puparium, *Pealius spinosus*, on unidentified tree, 8.x.1985, Augustine, (loaned by Prof. B.V. David); Karnataka: Yellapur, 1 puparium, on unidentified tree, 11.x.2001, A.K. Dubey.

10. ***Pealius splendens*** (David, Sundararaj & Regu) comb. nov.

Odontaleyrodes splendens David, Sundararaj & Regu 1991: *J. Insect. Sci. 4(2)*: 117-119.

The description by David *et al.* (1991) is adequate.

Distribution: INDIA: Kerala: Tripunithura (David *et al.* 1991).

Host plant: *Tectona grandis* (David *et al.* 1991).

Material examined: India: Kerala: Tripunithura, Holotype puparium, *Odontaleyrodes splendens,* on *Tectona grandis,* 30.vii.1987, B.V. David (loaned by Prof. B.V. David).

KEY TO THE INDIAN SPECIES OF *PEALIUS*

1. A dark brown patch on median area of first and second abdominal segments absent 2
— A dark brown patch on median area of first and second abdominal segment present .... *cinnamomi* (Sundararaj & David 1991)
2. A brown patch cephalad of cephalic seta absent 3
— A brown patch cephalad of cephalic seta present .... *indicus* (David 1972)
3. Submarginal setae present 4
— Submarginal setae absent ....*walayarensis* (Jesudasan & David 1991)
4. A submedian row of papillae present 5
— A submedian row of papillae absent 8
5. Setae on mesothorax/metathorax present 6
— Setae on mesothorax/metathorax absent 7
6. Setae present on meso- and metathorax; submedian papillae on cephalothorax and abdomen present .... *sairandhryensis* (Meganathan & David 1994)
— Setae present only on metathorax; submedian papillae only on abdomen present .....*misrae* (Singh 1931)
7. Puparium elliptical, 0.60-0.68 mm long, 0.40-0.47 mm wide, margin with 22 crenulations in 0.1 mm; vasiform orifice subrectangular (30 x 37.5 µm) .... *splendens* (David, Sundararaj & Regu 1991)
— Puparium elongately oval, 0.83 mm long, 0.44 mm wide; margin with 15 crenulations in 0.1 mm; vasiform orifice subcordate (47.5 x 37.5 µm) ....*elongatus* (David, Sundararaj & Regu 1991)
8. Transverse moulting suture not reaching margin 9
— Transverse moulting suture reaching margin 12
9. Thoracic tracheal pore not marked by small rounded teeth, subcircular rim near thoracic tracheal pore absent 10
— Thoracic tracheal pore marked by small rounded teeth, a subcircular rim near thoracic tracheal pore present ....*azaleae* (Baker & Moles 1920)
10. Submarginal setae less than 13 pairs and not in a row 11
— Submarginal setae in 13 pairs and in a row .... *bengalensis* (Peal 1903)
11. Puparium roundly elliptical; dorsum not tuberculate; 10 pairs of subdorsal and 2 pairs of submarginal setae evident .... *spina* (Singh 1931)
— Puparium oval; dorsum tuberculate; 9 pairs of subdorsal and 5 pairs of submarginal setae; shape and length of setae vary depending on hairy or glabrous nature of leaf surface on which it develops .....*simplex* (Singh 1931)
12. First abdominal setae present 13
— First abdominal setae absent ..... *nilgiriensis* (David 1972)
13. Tracheal combs not discernible .... *nagerkoilensis* (Jesudasan & David 1991)
— Tracheal combs discernible .... *schimae* (Takahashi 1950)

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THE FOOD OF THE HIMALAYAN NEWT *TYLOTOTRITON VERRUCOSUS* (ANDERSON): A PRELIMINARY STUDY[1]

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The present study investigates the diet of the Himalayan Newt *Tylototriton verrucosus* (Anderson) based on the specimens collected from Ukhrul and Senapati districts of Manipur. Barring sporadic reports on the occurrence of this species in this region, no detailed studies have been reported. The present study aims at examining the types of food material consumed by this animal on the basis of their gut contents. The food items of the specimens collected between April and October 1996 consisted of insects, insect larvae, millipedes, spiders, scorpions, molluscs, plant and inorganic matter, including pebbles, sand and mud, which are incidentally ingested along with the food.

Key words: gut, mollusc, *Lengva*, pebble, swampy area, chara

INTRODUCTION

The Himalayan Newt *Tylototriton verrucosus* (Anderson) (*Lengva* in Tangkhul) is found in Ukhrul and Senapati, the hill districts of Manipur (including the Siroi-Kasom Hill range of Ukhrul district, which extends up to Mao of Senapati district), at altitudes from 1,500 to 2,200 m above msl.

T. verrucosus is found in small numbers in small water pools and swampy areas of the northern and eastern hills of Manipur. Except Nair (1996), who stated that it feeds on aquatic vegetation, insect larvae, tadpoles and earthworms, no detailed information on the food items of this animal is available. This paper, therefore, aims to investigate the food items of *T. verrucosus* collected from Ukhrul (Hundung, Siroi, Kasom) and Senapati districts (Oinam Ching) of Manipur.

MATERIAL AND METHODS

Analysis of the gut (stomach and large intestine) content of *T. verrucosus* was carried out between April and October 1996. During this period, the animals were collected and stored in plastic bottles, containing 10 ml chloroform and thereafter 5% formaldehyde solution was injected into the stomach of each animal to preserve the organs and to check further mixing of the food particles with gastric juice. In the laboratory, the specimens were grouped on the basis of the month of collection. The stomach and the large intestine of each animal were removed and preserved separately in 70% alcohol.

The guts were later dissected longitudinally and their contents transferred to a petridish containing 70% alcohol. The contents were examined under a microscope, and later photographed and grouped as follows: 1. Insects: (a) Insect fragments, namely head, dissociated legs and wings, (b) Larvae of different types of insects; 2. Nematodes; 3. Millipedes; 4. Scorpions; 5. Spiders; 6. Molluscs; 7. Eggs of Himalayan Newt. They were further identified using diagnostic taxonomic characters.

RESULTS

The number of Himalayan Newts collected between April and October 1996 and the prey recorded are given in Table 1.

The primary food item of the newt was insects, which were identified using Richards and Davies (1977), Riley (1977) and Zanetti and Adriano (1977). The guts of the dissected newts contained scorpions, spiders (6 spiders were found in one individual), nematodes, millipedes, molluscs, and eggs of Himalayan Newts (Table 1). 25 Himalayan Newt eggs were found once in the gut of an individual, and 21 eggs were found in another. The eggs per gut range between 6-10. The newts start consuming eggs from June (see Table 1). No egg was found in the gut contents after August.

Materials found in the guts other than those described above are plants such as Blue Green Algae, pieces of straw and chara (Table 1). The newt feeds on a variety of insects belonging to different orders; Honey Bees (Table 2) were consumed in large numbers (22.29%) (Fig. 1).

The food items consumed by *T. verrucosus* (Anderson) appear to be dependant on the availability of insects and other organisms in the area during a specific period of the year. April marks the beginning of the warm season, which is usually punctuated by sporadic rains. Before the onset of heavier monsoon rains in June, the flowering of the number

Table 1: Month-wise number of Himalayan Newts and their prey

Sl. No.		April	May	June	July	Aug.	Sept.	Oct.	Total number of newts
1	Total No. of Newts examined	14	17	23	18	11	5	3	91
2	Guts with contents	9	15	19	17	8	4	2	74
3	Empty guts	5	2	4	1	3	1	1	17
4	Guts containing pebble, sand and mud	-	-	-	-	-	-	1	1
5	Guts containing plant materials	-	1	1	1	-	2	-	5
6	Guts containing eggs	-	-	1	4	3	-	-	8
7	Gut containing scorpion	-	-	-	-	-	-	1	1
8	Guts containing spider	-	1	1	-	-	-	-	2
9	Gut containing nematodes	-	-	-	-	-	1	-	1
10	Guts containing molluscs	-	2	2	-	-	-	-	4
11	Guts containing mixed items	-	-	4	6	1	-	-	11
12	Guts containing insects	9	11	10	6	4	1	-	41

of shrubs and many fruit-bearing plants of the area attracts a large number of insects. With the onset of heavy rains aquatic plants and insects are plentiful in the habitat. Many of these insects form the food items of the newt.

DISCUSSION

This study indicates that *T. verrucosus* feeds on insects belonging to several Orders. The food items contained in the

Table 2: Types and quantity of insects found in the guts of Himalayan Newt

Sl. No.	Insect Order	Insect	Months							Total (%)
			April	May	June	July	Aug.	Sept.	Oct.	
1	Odonata	(a) Dragon fly	2	1	-	-	2	-	-	5 (3.18)
2	Orthoptera	(a) Grasshopper	2	1	1	1	1	-	-	6 (3.82)
		(b) Praying Mantis	1	2	-	2	-	-	-	5 (3.18)
3	Hemiptera									
	(a) Heteroptera	Plant bug	-	5	3	3	-	-	-	11 (7.00)
	(b) Homoptera	Plant hopper	-	7	2	3	1	-	-	13 (8.28)
4	Coleoptera	(a) Beetles (adults and larvae)	-	6	3	-	5	2	-	16 (10.19)
		(b) Ground beetle larvae	1	-	-	-	-	-	-	1 (0.63)
5	Lepidoptera	(a) Caterpillar	-	-	7	12	-	-	-	19 (12.10)
		(b) Butterfly	3	-	-	-	-	-	-	3 (1.91)
		(c) Moth	-	4	2	-	-	-	-	6 (3.82)
6	Diptera	Flies	1	1	1	-	-	-	-	3(1.91)
7	Hymenoptera	(a) Ants	3	7	2	6	-	-	-	18 (11.45)
		(b) Honey bee (adult and larvae)	21	10	4	-	-	-	-	35 (22.29)
		(c) Wasps (adult and larvae)	6	9	1	-	-	-	-	16 (10.19)

(Total number of insects contained in the guts of 41 Himalayan Newts from April to October 1996 = 157)

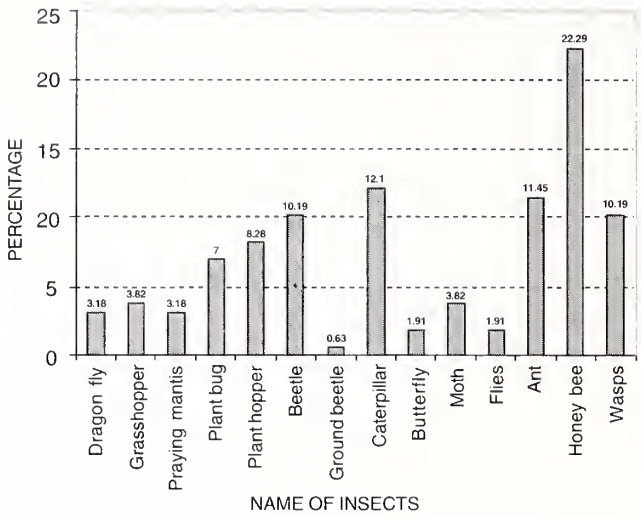

Fig. 1: Quantity of insects found in the guts of Himalayan Newt

gut of the newts collected between April and September are predominantly insects and insect parts. An interesting observation is that it also consumes its own eggs.

The rate of food consumption is high in May, June and July, declining after August. The gut of the newt is devoid of food materials in October. Voracious consumption of food coincides with the onset of reproductive activities in June. Apart from insects, which constitute the main food items of the newts, fragments of plants, small pebbles and mud were found in their guts. These are perhaps ingested incidentally. The rainy season starts in May and continues up to July; during this period the newts consume the small molluscs, which abound in their habitat. The newts lay eggs from June to August.

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FAUNAL DIVERSITY OF ROTIFERS (ROTIFERA: EUROTATORIA) OF DEEPOR BEEL, ASSAM (NORTHEAST INDIA) – A RAMSAR SITE[1]

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This pioneering taxonomic study on Rotifera of Ramsar sites of India deals with the analysis of plankton samples collected (from November, 2002 to October, 2003) from Deepor beel, a tropical floodplain lake of the Brahmaputra river basin of lower Assam (NE India). One hundred and ten species belonging to 35 genera and 20 families, documented in this study register the highest biodiversity of this phylum known till date from any aquatic ecosystem of the Indian subcontinent and reflects greater environmental heterogeneity of the sampled Ramsar site. The rotifer communities are characterized by Cosmopolitan (67.3%) > Pantropical (17.3%) > Cosmotropical (10.0%) elements, predominance of Lecanidae > Brachionidae > Lepadellidae > Trichocercidae, general tropical characters and several biogeographically interesting elements and acidophilus species. Species richness (43-65; 56 ±6 species) depicts trimodal monthly pattern with peak and minima during winter and early summer respectively, and shows 45.1-82.5% community similarity (*vide* Sorenson's index). The richness registers significant inverse correlation with water temperature, rainfall, free CO_2 and Calcium, and direct relationship with specific conductivity, dissolved oxygen and BOD_5. Our observations indicate lack of definite periodicity of occurrence of different species or families or groups of rotifers and record fewer perennial species. The examined collections show dominance of littoral or periphytic elements, fewer planktonic species and relatively higher number of small-sized taxa. Sladecek's $Q_{B/T}$ quotient depicts mesotrophic-eutrophic nature of Deepor beel.

Key words: Ramsar site, Rotifera, biodiversity, distribution, temporal variations

INTRODUCTION

Floodplain lakes (locally known beels) attract special global interest for their rich aquatic biodiversity and great biogenic production potential. These interesting ecotones comprise an integral component of the valley districts of Assam and Manipur of northeast India. Beels cover an area of 0.1 million ha of Assam, and constitute about 93% of its total fish-prone (i.e. area under fisheries) and play vital role in the socio-economic development of the region. Of these, Deepor beel, one of the largest wetland in the Brahmaputra valley of lower Assam, is under severe environmental pressure because of human encroachment and general degradation. This water body of great economic importance has been designated as a Ramsar site in November 2002, and attempts are being initiated for its biodiversity conservation. Very little is known about the micro-faunal diversity of this ecosystem (www.wwfindia.org) and information on rotifers is still lacking. This pioneering taxonomic study on the Rotifera of Ramsar sites of India assumes significance in view of limited works on biodiversity of this phylum (Sharma and Sharma 2001) from the floodplain lakes of India, in general, and that of the Northeast region in particular. The observations are made on species composition of the rotifer taxocoenosis of Deepor beel with remarks on its general nature and composition, species richness, temporal variations, community similarities, interesting elements and on trophic status of the wetland based on the rotifer taxa (*vide* Sladecek's quotient).

MATERIAL AND METHODS

The present study is a part of limnological survey, undertaken during November 2002 to October 2003, in Deepor beel, a perennial floodplain lake (26° 03' 26" N and 90° 36' 39" E; area: 40 km^2; altitude: 42 m above msl) located in the Kamrup district of lower Assam. This beel is covered with luxuriant growth of diverse aquatic macrophytes, namely *Hydrilla verticillata*, *Naias indica*, *Euryale ferox*, *Vallisnaria spiralis*, *Utricularia flexuosa*, *Trapa bispinosa*, *Eichhornia crassipes*, *Monochoria hastaefolia*, *Xanthium straumarium*, *Ipomea fistulosa*, *Croton borplandianum*, *Hydrorhiza aristata*, *Polygonum hydropiper* and *Limnophila* sp. Water samples, collected monthly, were analyzed for various abiotic factors following APHA (1992) while water temperature, specific conductivity, pH, transparency and dissolved oxygen were recorded by field probes. Qualitative plankton samples were obtained regularly every month by towing nylobolt plankton net (No. 25) from different parts of the beel and preserved in 5% formalin. These samples were subsequently screened for various rotifer species and their permanent mounts were made

in polyvinyl alcohol-lactophenol mixture. The rotifer taxa were identified following Kutikova (1970), Koste (1978), Koste and Shiel (1990), Segers (1995) and Sharma and Sharma (1999, 2000). In addition, Segers (2002) was followed for the recent nomenclature of Rotifera. Percentage similarities between monthly rotifer communities were calculated *vide* Sorensen index. Ecological relationships were computed *vide* simple correlation coefficients (r). $Q_{B/T}$ quotient (Sladecek 1983) has been used to comment on the general trophic status of the wetland.

RESULTS AND DISCUSSION

Deepor beel is characterized (Table 1) by low ionic concentration which warrants its inclusion under 'Class I' category *vide* Talling and Talling (1965). Mean water temperature affirms tropical range related to its geographical location. Circum-neutral and marginally hard waters of this floodplain lake depict moderate dissolved oxygen, low free CO_2, low concentration of micro-nutrients and other abiotic factors. Chloride and BOD_5 reflect some possible impact of human activity on this Ramsar site. The ranges of the recorded abiotic factors agree with earlier reports of Sharma and Hussain (1999), Sharma (2000a, b) and Sharma and Sharma (2001).

The present study reveals the highest diversity of Eurotatoria (110 species, 35 genera and 20 families) known till date from any aquatic environ of the Indian subcontinent

Table 1: Abiotic factors of Deepor beel

Factors	Mean ± SD
Rainfall (mm)	195.4 ± 158.2
Water temperature (°C)	27.4 ± 4.6
pH	7.03 ± 0.2
Transparency (cm)	56.9 ± 24.0
Specific Conductivity (µS/cm)	103.8 ± 14.6
Dissolved oxygen (mg/l)	6.4 ± 1.9
Free CO_2 (mg/l)	6.2 ± 2.2
Alkalinity (mg/l)	68.6 ± 10.6
Hardness (mg/l)	63.5 ± 10.5
Calcium (mg/l)	19.7± 1.8
Magnesium (mg/l)	3.9 ± 0.5
Chloride (mg/l)	24.7 ± 4.4
Dissolved Organic Matter (mg/l)	2.33 ± 0.37
Total dissolved Solids (mg/l)	1.69 ± 0.46
Phosphate (mg/l)	0.14 ± 0.04
Sulphate (mg/l)	9.0 ± 2.7
Nitrate (mg/l)	0.65 ± 0.17
Silicate (mg/l)	2.78 ± 0.71
B.O. D_5 (mg/l)	2.23 ± 0.63
Sodium (mg/l)	13.4 ± 1.9
Potassium (mg/l)	4.46 ± 0.75

(Table 2). The rich and diversified rotifer taxocoenosis is undoubtedly an indicator of greater environmental heterogeneity of the Deepor beel and thus concurs with generalizations of José de Paggi (1993), Bonecker *et al.* (1998) and Shiel *et al.* (1998) on floodplain lakes of Argentina, Brazil and Australia respectively. Besides, this salient feature lends significant support to the hypothesis of Segers *et al.* (1993) indicating (sub) tropical floodplains to be the world's richest habitats for rotifers. The documented species comprise notable fraction (30.9%) of the Indian Rotifera and the fauna of NE India (57.6 %). Overall, rotifer richness of this Ramsar site compares well with 111 species from floodplains of Argentina (José de Paggi 1993); is marginally higher than the 104 species from Laguana Bufeos, Bolivia (Segers *et al.* 1998) and is lower than the reported 136 species (Iyi-Efi lake) and 124 species (Oguta lake) in the Niger delta (Segers *et al.* 1993), and 130 species from Lake Guarana, Brazil (Bonecker *et al.* 1994).

Referring to the Indian conditions, the rotifer diversity of Deepor beel presents a significant increase in the peak value of 65 species recorded by Sharma and Sharma (2001) from Dighali beel, Assam and exceeds the recent highest record of 103 species again from Dighali beel (Sharma 2005). The richness is distinctly higher than the reports of only 29 species from four beels (Goswami 1997), 48 species from 33 beels (Sarma 2000), 54 species from five beels (Sharma 2000b) and 9 species from Mori beel (Goswami and Goswami 2001) of Assam state. It is also significantly higher than 11 species from two floodplain lakes of Kashmir (Khan 1987) as well as of 37 species from two Ox-bow lakes (Khan 2002), and 38 species from 9 floodplain lakes (Khan 2003) of South-eastern West Bengal. The poor records in several Indian works are in fact not due to actual paucity of rotifers in the floodplain lakes, but due to inadequate sampling, overlooking identification of smaller taxa and incomplete analysis due to lack of taxonomic expertise (BKS *pers. comm.*). Interestingly, the rotifer richness of this floodplain lake of the Brahmaputra river basin corresponds to the 110 species from the backwaters of the river Yamuna at Delhi (Arora and Mehra 2003). This study, however, shows only 50% community similarity with the latter, and hence shows significant divergence in the communities of two environs.

Lecanidae (30 species) > Brachionidae (19 species) > Lepadellidae (15 species) > Trichocercidae (7 species) constitute a dominant fraction (64.6%) of Rotifera of Deepor beel and of their monthly composition (54.5-69.8%, 60.1±4.2%). The stated dominance trend corresponds with the reports from floodplains of South America (Bonecker *et al.* 1994, 1998; Lansac-Tôha *et al.* 1997; Rossa 1997; Serafim 1997), Argentina (José de Paggi 1993, 2001), Africa (Segers *et al.* 1993), Bolivia (Segers *et al.* 1998), Thailand (Sanoamuang 1998) and India

Table 2: Rotifer Taxocoenosis of Deepor Beel

Reported taxa	Months
Family: **Brachionidae**	
Anuraeopsis fissa (Gosse)	N, F, M, JL-O
Brachionus angularis Gosse	N-AP, JL-O
B. bidentatus Anderson	N-MA, M, JL, O
B. calyciflorus Pallas	D-MA, JL, A, O
B. caudatus Barrois & Daday	N-O
B. diversicornis (Daday)	D-AP, J, S
B. donneri Brehm	AP, J
B. falcatus Zacharias	N-O
B. forficula Wierzejski	N-M, JL-S
B. mirabilis Daday	JN, J-A, O
B. quadridentatus (Hermann)	N-O
B. rubens Ehrenberg	AP-J
Keratella cochlearis Gosse	N-O
K. tropica (Apstein)	N-O
K. lenzi Hauer	N-F, M-O
K. procurva (Thorpe)	JN, AP-A
K. quadrata (Müller)	N-D, F-MA, J, A, O
Platyias quadricornis (Ehrenberg)	N-O
Plationus patulus (Müller)	N-O
P. patulus macracanthus (Daday)	N-O
Family: **Epiphanidae**	
Epiphanes brachionus (Ehrb.)	D, JL, A, S
Family: **Euchlanidae**	
Euchlanis dilatata Ehrenberg	N-O
E. incisa Carlin	D-JN
E. triquetra Ehrenberg	N, M
Dipleuchlanis propatula (Gosse)	N, D, F, M, JL, A, O
Beauchampiella eudactylotum (Gosse)	JN, J
Family: **Mytilinidae**	
Mytilina bisulcata (Lucks)	N-JN, M, J, O
M. ventralis (Ehrenberg)	N-F, M, J, A, S
Family: **Trichotriidae**	
Macrochaetus sericus (Thorpe)	N-MA, M-S
Trichotria tetractis (Ehrenberg)	N-F, M-S
Family: **Lepadellidae**	
Colurella obtusa (Gosse)	N, JN -MA, M, S
C. uncinata (Müller)	D-JN, MA-AP, JL, S
Lepadella acuminata (Ehrenberg)	N, MA, J
L. aspicora (Myers)	JN, O
L. apsida Harring	D-JN, A
L. biloba Hauer	S
L. discoidea Segers	A
L ehrenbergi (Perty)	N, F-MA, M, O
L. heterostyla (Murray)	N, JN, MA, A, O
L. minuta (Montet)	D, AP
L. ovalis (Müller)	D-MA, J-A, O
L. patella (Müller)	N, F-MA, JL, S, O
L. rhomboides (Gosse)	N, JN-M, JL-S
L. triptera Ehrenberg	D, AP
Squatinella mutica (Ehrenberg)	N, MA, M-A, O

Reported taxa	Months
Family: **Lecanidae**	
Lecane aculeata (Jakubski)	N, JN-MA, M, JL, S
L. bulla Gosse)	N-O
L. closterocerca (Schmarda)	D, F, M-O
L. crepida Harring	D, AP, J
L. curvicornis (Murray)	N-MA, M, J, A-O
L. decipiens (Murray)	JN, M, S-O
L. furcata (Murray)	AP, JL
L. hamata (Stokes)	N-F, M, S
L. hastata Murray	JL
L. hornemanni (Ehrenberg)	N, F, M, A
L. inermis (Bryce)	N, MA, AP
L inopinata Harring & Myers	M, JL, S
L. leontina (Turner)	N-O
L. ludwigii (Eckstein)	A
L. luna (Müller)	D, F-MA, J,A,O
L. lunaris (Ehrenberg)	D-F, A-S
L. monostyla (Daday)	N, AP
L. nana (Murray)	AP, J, S
L. obtusa (Murray)	O
L. ohioensis (Herrick)	AP, M, JL, A, O
L. papuana (Murray)	D-JN, MA, J-S
L. ploenensis (Voigt)	N, JN-F, J, A, O
L. pertica Harring & Myers	N-D, O
L. pyriformis (Daday)	JN, AP, JL, S-O
L. quadridentata (Ehrenberg)	N-F, M, A-O
L. sola Hauer	MA, AP
L. stenroosi (Meissner)	N, MA
L. thienemanni (Hauer)	F-MA, J-A
L. unguitata (Fadeev)	N-JN, AP, M, JL-S
L. ungulata (Gosse)	N-O
Family: **Notommatidae**	
Cephalodella forficula (Ehrenberg)	JN, F, MA,JL-S
C. gibba (Ehrenberg)	D, F, AP
C. mucronata (Harring & Myers)	O
Monommata longiseta (Müller)	N-F, MA, A-O
Family: **Scaridiidae**	
Scaridium longicaudum (Müller)	D-MA, M-J, S
Family: **Trichocercidae**	
Trichocerca cylindrica (Imhof)	N, D, F, J, A, O
T. capucina (Wier. & Zach.)	N, JN, F, MA, J, A, O
T. elongata (Schrank)	N-F, AP, A, S
T. longiseta (Schrank)	N-F, J, A, S
T. porcellus (Gosse)	N, JN-MA, JL, A, O
T. rattus (Müller)	D, MA, AP
T. similis (Wierzejski)	N, J, F, MA, JL,S
Family: **Asplanchnidae**	
Asplanchna priodonta Gosse	N-O
Family: **Synchaetidae**	
Polyarthra vulgaris Carlin	N-O

Table 2: Rotifer Taxocoenosis of Deepor Beel (*contd.*)

Reported taxa	Months	Reported taxa	Months
Family: Dicranophoridae		*F. longiseta* (Ehrenberg)	N, J-F, MA, J-S
Dicranophorus forcipatus (Müller)	D-F, M, J, A, S	*F. opoliensis* (Zacharias)	N-MA, J, S
		F. pejleri (Hutchinson)	D, F, M, M-JL, S, O
Family: Flosculariidae			
Floscularia ringens (Linnaeus)	A	**Family: Testudinellidae**	
Lacinularia flocculosa (Müller)	S	*Testudinella brevicaudata* Yamamoto	A, S
Limnias ceratophylli Schrank	O	*T. emarginula* (Stenroos)	JN-MA, O
Sinantherina spinosa (Thorpe)	N-O	*T. greeni* Koste	D, JL
S. socialis (Linnaeus)	MA-A	*T. patina* (Hermann)	N-O
		Pompholyx sulcata Hudson	MA
Family: Conochilidae			
Conochilus unicornis Rousselet	N-O	**Family: Trochosphaeridae**	
		Trochosphaera aequitorialis Semper	D-J, MA-A, O
Family: Hexarthridae			
Hexarthra mira (Hudson)	JN, J, O	**Family: Philodinidae**	
		Rotaria rotatoria (Ehrenberg)	N
Family : Filiniidae		*R. neptunia* (Ehrenberg)	N, MA, M, S
Filinia brachiata (Rousselet)	O	*Philodina* sp.	N
F. camascela Myers	D-S		

Abbreviations (months): N-November, D-December, JN-January, F-February, MA-March, AP-April, M-May, J-June, JL-July, A-August, S-September, O-October

(Sharma and Sharma 2001). This trend also confirms with the composition of the Indian Rotifera (Sharma 1998). In addition, Euchlanidae = Filiniidae = Testudinellidae = Flosculariidae > Notommatidae comprise an important component (22.7%). Qualitative significance (37.3%) of 'tropic-centered' genera namely *Lecane* (30 species) and *Brachionus* (11 species) imparts tropical character to the rotifer fauna of Deepor beel affirming such generalizations on other tropical faunas (Fernando 1980; Dussart *et al.* 1984; Segers 1996). This conclusion is, in turn, supported by paucity of 'temperate-centered' *Keratella* (5 species). *Lecane* spp. alone comprise a notable fraction (27.3%) and their dominance compares with the rotifer communities of other floodplains (Segers *et al.* 1993, 1998; Sanoamuang 1998; Josè de Paggi 2001).

The predominance of cosmopolitan species (67.3%), another salient feature of this study, concurs with the results of Sharma and Sharma (2001). Besides, pantropical > cosmotropical species together form notable component (27.3%). The examined material includes four interesting palaeotropical elements, namely *Testudinella greeni*, *T. brevicaudata*, *Lecane unguitata* and *Lepadella discoidea*. The first two species are so far recorded only from the floodplains of NE region while the lecanid is apparently widely distributed in India. *L. discoidea* is known from Indonesia, Australia, Zaire, Nigeria and Papua New Guinea while its Indian reports are from Delhi and the northeastern state of Assam. Segers (1993) proposed possible inclusion of the new taxon *Lepadella ovalis* f. *larga* described by Sharma (1978) from West Bengal under the former species. The specimens from West Bengal are larger than Segers' species (*L. discoidea*) and more material is required to ascertain correct status of the Indian taxon. Other biogeographically important elements recorded presently are the pantropical *Brachionus donneri*, *Lecane pertica*, *L. hastata*, *L. thienemanni*, *Filinia camascela* and *Trochosphaera aequitorialis*. In addition, the colonial *Sinantherina spinosa*, the sessile *Floscularia ringens*, *Lacinularia flocculosa* and *Limnias ceratophylli* as well as cosmopolitan *Lepadella biloba*, *L. minuta* and *Lecane sola* are examples of regional distributional interest. Among these, *B. donneri* and *L. sola* deserve special mention as species originally described from this country. A majority of the stated species are rare in our material and also represent rare elements in the Indian fauna.

Qualitative abundance of periphytic or littoral elements (76.2%) and occurrence of fewer planktonic species (23.8%) indicate lack of definite pelagic habitats (De Manuel 1994) which, in turn, can be attributed to shallow nature of Deepor beel as well as the presence of aquatic macrophytes. Our observations exhibit frequent occurrence of non-planktonic taxa in open waters of the sampled lake; this feature of establishment of both planktonic and non-planktonic taxa in beel with marginal vegetation suggests occupation of different niches (Bonecker *et al.* 1998). Besides, the present study indicates occurrence of a number of small-sized rotifer

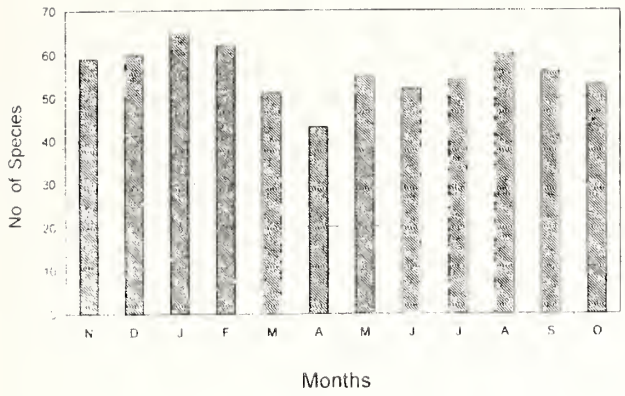

Fig 1: Species richness of Rotifera

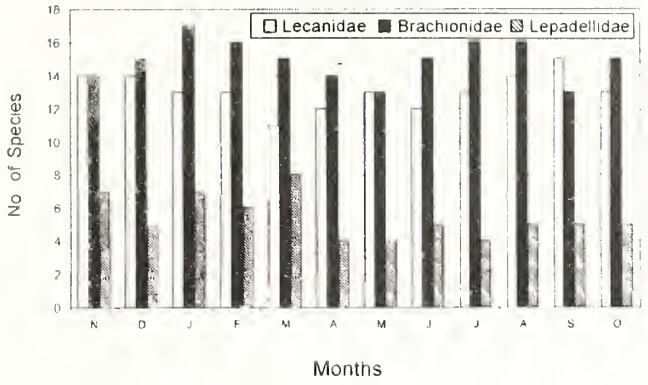

Fig 2: Species richness of dominant families

taxa, which may be attributed to conditions of low concentrations of food (Papinski 1990) and predation by fish and invertebrates (Baumgartner *et al.* 1997). The former aspect is supported by lower phytoplankton density and primary productivity of Deepor beel (Sharma unpublished).

Acidophilus elements (Koste 1978) reported presently include *Plationus patulus macracanthus*, *Dipleuchlanis propatula*, *Euchlanis triquetra*, *Mytilina bisulcata*, *Lepadella acuminata*, *Lecane pertica*, *Monommata longiseta* and *Testudinella emarginula*. The relative paucity of *Brachionus* (11 species) in general is attributed to acidic-circum neutral nature of the sampled beel. Only sixteen rotifers (14.5 %) namely *Brachionus caudatus*, *B. falcatus*, *Plationus patulus*, *P. patulus macracanthus*, *Platyias quadricornis*, *Keratella cochlearis*, *K. tropica*, *Euchlanis dilatata*, *Lecane bulla*, *L. leontina*, *L. unguitata*, *Asplanchna priodonta*, *Polyarthra vulgaris*, *Sinantherina socialis*, *Conochilus unicornis* and *Testudinella patina* represent perennial elements. Twenty eight species (25.4%) i.e., *Brachionus angularis*, *B. bidentatus*, *B. falcatus*, *B. forficula*, *B. quadridentatus*, *Anuraeopsis fissa*, *Keratella cochlearis*, *K. tropica*, *Plationus patulus*, *Euchlanis dilatata*, *Mytilina ventralis*, *Trichotria tetractis*, *Lepadella ovalis*, *L. rhomboides*, *Lecane bulla*, *L curvicornis*, *L. luna*, *L. leontina*, *L. papuana*, *L. ungulata*, *L. lunaris*, *Polyarthra vulgaris*, *Testudinella patina*, *Trichocerca porcellus*, *T. similis*, *Filinia longiseta*, *F. opoliensis* and *F. camascela* exhibit common occurrence while *Brachionus mirabilis*, *Mytilina bisulcata*, *Lepadella apsida*, *L. minuta*, *L. discoidea*, *Lecane hastata*, *L. monostyla*, *L. furcata*, *L. sola*, *Filinia brachiata*, *Testudinella brevicaudata* and *T. greeni* are rare elements.

The present observations depict qualitative predominance of rotifers in Deepor beel throughout the study period and this trend concurs with the results of Sarma (2000), Sharma (2000a, b), Sharma and Sharma (2001) and Khan (2002). The richness (43-65; 56 ±6 species) shows a trimodal pattern of temporal variations (Fig. 1) with peak during January (winter) and minima in April (early summer). In general, higher richness (60-65 species) noticed during winter (December-February) is supported by significant inverse correlation with water temperature (r = -0.764) while it also records inverse relationship with rainfall (r = -0.516), free CO_2 (r = -0.469) and Calcium (r = -0.442). Species richness, however, registers significant direct correlation with specific conductivity (r = 0.534), dissolved oxygen (r = 0.469) and BOD_5 (r = 0.474). Three eurotatorien families namely Brachionidae (13-17; 15 ±1 species) > Lecanidae (11-15; 13 ±1 species) > Lepadellidae (4-8; 5 ±1 species) mainly influence (Fig. 2) temporal variations of rotifer diversity, but do not follow any definite seasonal or monthly trend. The later generalization also holds true for occurrence of different species. The communities similarity (45.1- 82.5%) depicts distinct variations in species composition. Peak similarity is noted between the samples collected in February and July, while April registers lowest similarity (45.1-59.6%) with other monthly samples. Further, the matrix indicates (Table 3) fewer cases of < 50% and > 80% similarity, which ranges between 60-70% in majority (48.6%) of instances.

Sladecek (1983) proposed $Q_{B/T}$ quotient based on ratios between *Brachionus* : *Trichocerca* species to depict trophic status of different ecosystems or even individual samples. The utility of application of this quotient under Indian conditions is ascertained by Sharma and Dudani (1992) and Sharma (2000a). The present results indicate $Q_{B/T} = 2.4$ and, thereby, reflect general mesotrophic status of Deepor beel while its monthly values ranging between 1.4-4.5 indicate mesotrophic nature with shift towards eutrophy in certain months. This generalization is broadly affirmed by water quality of the wetland and temporal variations of various parameters during the study period.

To conclude, this study provides an exhaustive

Table 3: Percentage similarities (Sorenson's index) between Rotifer communities

Months	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct
November	-	62.2	66.1	76.0	63.6	45.1	66.7	54.0	58.4	63.9	64.3	64.3
December		-	73.6	70.5	57.6	48.5	60.9	66.1	61.4	70.0	68.9	65.5
January			-	77.2	67.2	51.8	71.7	68.4	68.9	73.6	77.7	62.0
February				-	72.6	47.6	73.5	82.4	67.2	75.4	74.6	66.1
March					-	59.6	58.5	62.1	64.8	59.5	63.6	55.5
April						-	51.0	50.5	51.5	52.4	52.5	45.5
May							-	61.7	73.4	66.0	68.5	57.4
June								-	60.4	69.6	61.1	60.9
July									-	73.7	67.3	61.7
August										-	67.3	63.6
September											-	46.3
October												-

inventory of the rotifer taxa of the sampled Ramsar site and exhibits rich and diversified nature of the examined taxocoenosis. The rotifer communities are predominated by the monogonont taxa. Planktonic and littoral species are well documented in this study while epiphytic, benthic and bdelloids still need specific attention. The observations on the rotifer communities in relation to diverse aquatic macrophytes in this ecotone will be of special future interest to analyse species associations and horizontal distributional patterns.

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A PRELIMINARY SURVEY ON FRESHWATER ALGAL FLORA OF GARUDA TAL, NEAR NAINITAL, UTTARANCHAL, INDIA[1]

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Garuda Tal (lake) is located 23 km from Nainital town of Uttaranchal state in Kumaon division, and situated in the foothills of the Himalaya, at an altitude of 1450 m above msl. An assessment of the diversity of freshwater algal flora of Garuda Tal resulted in a total of 19 species, representing 15 genera of which 3 species were Blue-green Algae (Cyanophyceae), 5 species were Green Algae (Chlorophyceae), and 11 were Diatoms (Bacillariophyceae). *Rhizoclonium, Spirogyra* and *Gomphonema* were abundant in this lake. A preliminary survey and morpho-taxonomic details of freshwater algal flora of Garuda Tal has been described in the present communication.

Key words: freshwater algal flora, diversity, Garuda Tal

INTRODUCTION

Nainital district (29° 24' N and 79° 28' E; area 11.73 sq. km) of Uttaranchal lies in the Kumaon division abutting Himalayan ranges to its north, at an altitude of 1938 m above msl. This area is highly mountainous marked with rugged topography, comprising of high ranges, steep hills, deep valleys, cliffs and sloping meadows. Gola and Kosi rivers flow through this region along with a number of small streams and lakes. The present contribution is the result of preliminary studies carried out on the freshwater algal flora of Garuda Tal, a serene lake.

Garuda Tal is situated 23 km from Nainital town at an altitude of 1450 m above msl. The lake is about 745 m long, 300 m broad and 19 m deep (Das 2003) and lies at the foothills of Western Himalaya. This serene lake is not disturbed by anthropogenic activities; its lush green water is surrounded by thick, tall pine, oak trees along with several herbs and shrubs. The soil of this hilly region varies from loamy to clay loamy. The climate is tropical with cool summers and extremely cold winters. The atmospheric temperature varies from 3-16 °C in winter and 10-28 °C in summer; the average rainfall is 260 cm (National Information Centre, Dehradun, 2000-2005). The temperature of the water varied from 14-16 °C and the pH was 5.5 during the study period.

MATERIAL AND METHODS

A total of 14 freshwater algal samples were collected during May 2002 from Garuda Tal with the help of a simple sample collecting spoon with a long handle. Epilithic algal samples were collected by scraping submerged rocks. Some of the samples were collected by hand squeezing the aquatic plants of the lake. Samples stored in 50 ml sample bottles were preserved in 4% formalin and deposited in the collections of the Phycology laboratory, National Botanical Research Institute, Lucknow. The samples were observed under an Olympus light microscope and camera lucida diagrams were drawn. For diatoms, permanent slides were prepared as per Patrick and Reimer (1966). Taxonomic identification was done as per Desikachary (1959), Jeffery *et al.* (1983), Noda and Lorin (1985), Prasad and Srivastava (1992), Prescott (1951), and Tzanou and Economou (1995).

RESULTS

Among the freshwater algal flora, green algae, blue-green algae and diatoms were identified and their taxonomic descriptions are given below:

Cyanophyceae

Chroococcus minutus (Kuetz) Naegeli (Fig. 2)

A small amorphous, mucilaginous mass in which spherical or hemispherical cells are compactly arranged within a wide hyaline envelope, individual cell sheaths indistinct not lamellate, cell contents blue green, either homogenous or finely granular, cells 5-10 µm in diameter.

Gloeothece samoensis Wille (Fig. 3)

Cells ellipsoidal, without sheath 4-5 µm broad, 8 µm long, cells yellowish or bluish green, in round colonies, mostly 2-4 in a common envelope, envelope colourless.

Oscillatoria nigra Vaucher (Fig. 1)

Trichomes aggregated to form a thick, mucilaginous blackish green mass on submerged objects, becomes free floating, straight or slightly tapering towards the apex and curved, apical cell rotund not capitate without calyptra; cells

8-10 µm in diameter, 4.5 µm long, not constricted at the cross walls, which are sometimes granular, cell content dark olive green.

Chlorophyceae

Rhizoclonium hookeri Kuetzing (Fig. 8)

Filaments crisp, freely branching, composed of long, cylindrical or regularly inflated cells, cell 68 µm in diameter, 380 µm long. An epilithic alga found attached to submerged rocks. *Licmophora flabellata* is an epiphyte on its filament.

Bulbochaete dispar Wittrock (Fig. 10)

Branched filament arising from a basal cell, which has a holdfast organ. Cells cylindrical, ovoid, having successive divisions at the basal cell only, bearing a long seta with a bulbous base. Vegetative cells 35 µm in diameter, 30-40 µm long.

Closterium pseudodianae Roy, West & West **var.** ***curvata*** Kant & Gupta (Fig. 9)

Cells much longer than the type, curved at both the ends, sickle shaped, chloroplast divided into two halves, end pointed or rounded, cells 440-450 µm long, 50 µm in diameter.

Ankistrodesmus falcatus (Corda) Ralfs **var.** ***radiatus*** (Chodat) Lemm. (Fig. 11)

Acicular cells not twisted around each other, arranged in radiating bundles, cells straight or curved, 61-73 µm long, 4.5-5.0 µm in diameter.

Cosmarium medioscrobiculatum West & West **var.** ***egranulatum*** Gutw. f. ***major*** Pandey & Pandey (Fig. 12)

Granules are uniformly distributed and there are no scrobicutations in the centre of the semi cells. Cells 50 µm broad, 90 µm long, and isthmus 32 µm wide.

Spirogyra **sp.** (Fig. 4)

Vegetative cells 260 µm long, 38 µm in diameter with plane end walls, chloroplast 2-3 making 2.5-3 turns.

Spirogyra **sp.** (Fig. 5)

Vegetative cells 200 µm long, 22 µm in diameter with plane end walls, chloroplast 1 making 4 turns.

Spirogyra **sp.** (Fig. 6)

Vegetative cells 210 µm long, 34 µm in diameter with plane end walls, chloroplast 1 making 3 turns.

Spirogyra **sp.** (Fig. 7)

Vegetative cells 240 µm long, 72 µm in diameter with plane end walls, chloroplast 3 making 3 turns.

Bacillariophyceae

Cocconeis pseudomarginata Gregory (Fig. 22)

Rapheless valves with lanceolate sternum and two zones of striae separated by longitudinal hyaline area. Valves 52 µm long, 35 µm wide with delicate radiate striae, marginal striae 13 in 10 µm, axial striae 16 in 10 µm. Raphe with polar nodule small extending downwards into an arrow shaped hyaline area.

Cocconeis diruptagreg **var.** ***flexella*** (Janish & Rabenhorst) Grunow (Fig. 23)

Differentiated from the nominate variety by the sigmoid axial of the rapheless valve. Valves 40 µm long, 24 µm wide with 19-20 striae in 10 µm, in the rapheless valve.

Cymbella tumida (Breb.) Vanheurck (Fig. 14)

Valves asymmetrical, curved, broadly naviculoid with rostrate poles, convex dorsal side and straight or slightly convex ventral sides having medium expansion, raphe eccentric, axial area narrow, central area large, round with a ventrally placed prominent isolated dot, transverse striation radiate, punctate, cells 18-20 µm in diameter, 52 µm in length, striae 10 in 10 µm.

Cymbella ventricosa Kuetzing (Fig. 13)

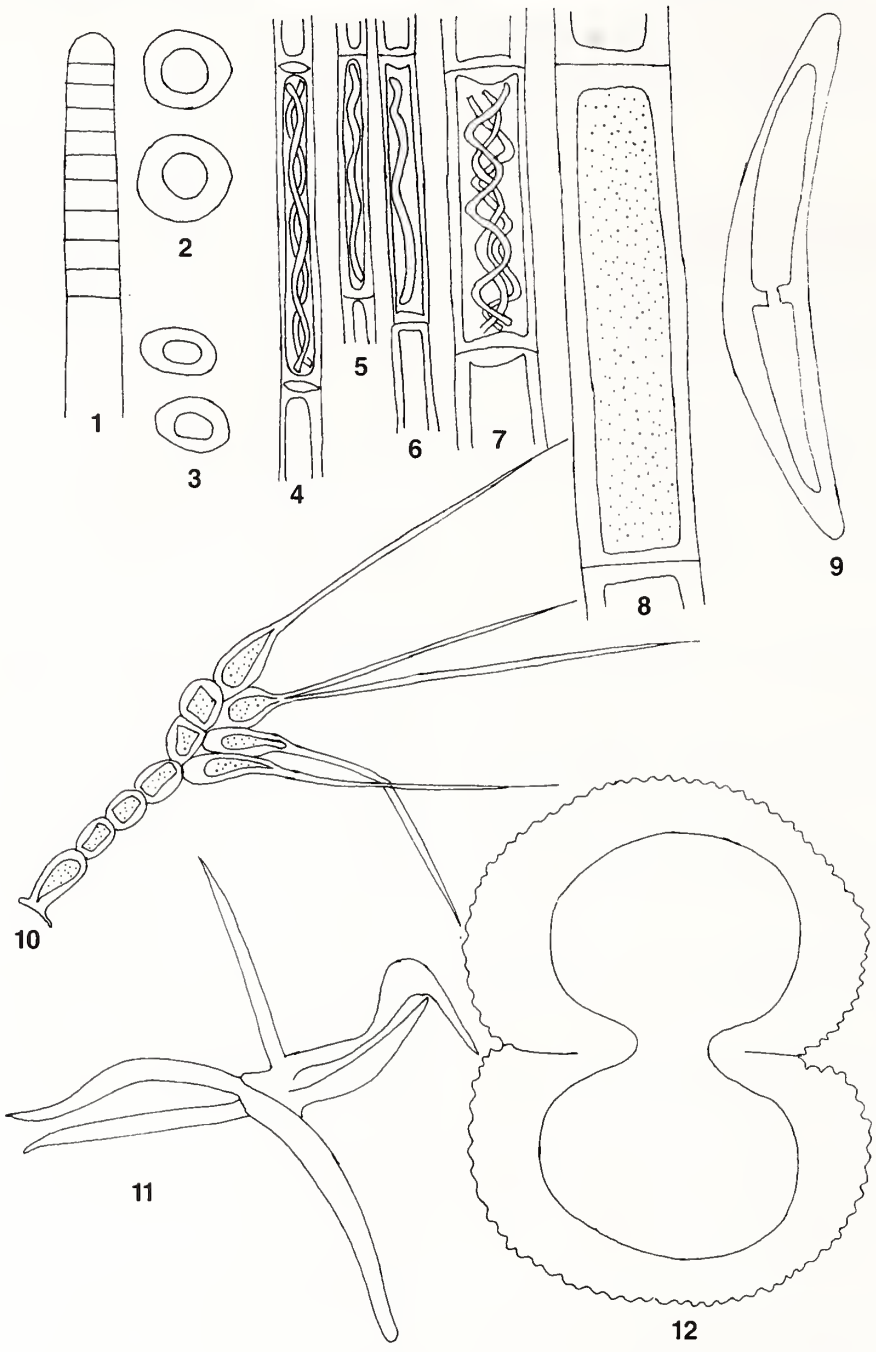
Valves asymmetrical, lunate with dorsal margin convex and ventral margin almost straight, ends acutely rounded, raphe thick, eccentric, slightly undulate, central nodules bent dorsally, while terminal fissure curved ventrally forming a question mark, axial area narrow, linear central area broad, striae coarse, lineate radiate throughout the wall, cells 18 µm in diameter, 65 µm in length, striae 10-11 in 10 µm.

Amphora veneta Kuetzing (Fig. 19)

Frustules oblong, elliptical with truncated rounded ends, in valve view, linear lunate with constricted, ventrally bent, obtusely rounded ends, dorsal side convex but ventral side somewhat concave, raphe thin, straight, eccentric, terminal fissure bent ventrally, axial area narrow, linear, striae lineate, radiate throughout, present on dorsal side. It is 30 µm long, 10 µm broad, striae 15 in 10 µm.

Amphora coffeaeformis Agardh (Fig. 20)

Valves linear, semi-lanceolate with constricted much produced rounded ends, dorsal margin broadly arcuate, ventral margin straight or concave, raphe thin eccentric, slightly undulate, central nodule bent dorsally, axial narrow, gradually widening towards centre, dorsal striae coarse



Figs 1-12: 1. *Oscillatoria nigra* 10 x 40; 2. *Chroococcus minutus* 10 x 40; 3. *Gloeothece samoensis* 10 x 40; 4. *Spirogyra* sp. 10 x 10; 5. *Spirogyra* sp 10 x 10; 6. *Spirogyra* sp 10 x 10; 7. *Spirogyra* sp. 10 x 10; 8. *Rhizoclonium hookeri* 10 x 10; 9. *Closterium pseudodianae* var *curvata* 10 x 10; 10. *Bulbochaete dispar* 10 x 10; 11. *Ankistrodesmus falcatus* var *radiatus* 10 x 40; 12. *Cosmarium medioscrobiculatum* var *egranulatum* f. *major* 10 x 40

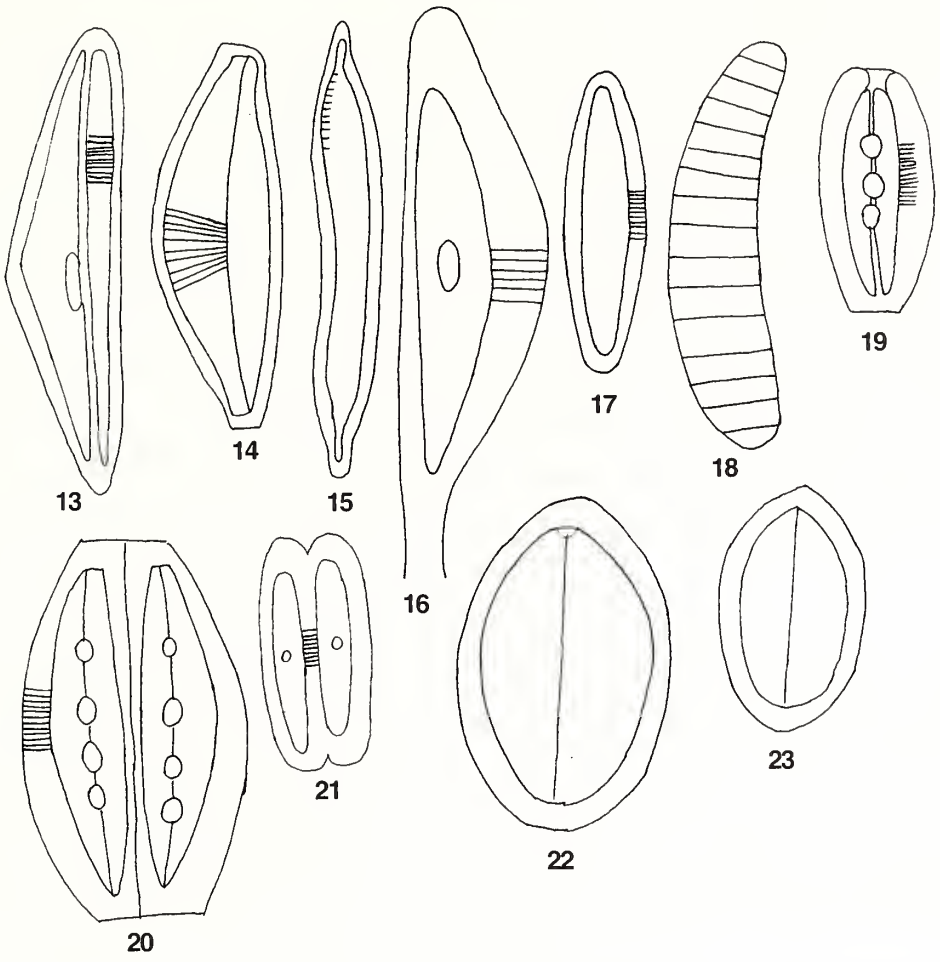
lineate, radiate, parallel throughout the valve, ventral striae very short, fine and close. It is 53 µm long, 20 µm broad, dorsal striae 11-13 in 10 µm, and ventral striae 20-22 in 10 µm.

Amphora clevei Grun. (Fig. 21)

Frustules crescent shaped in valve view, broadly elliptic with truncated poles in girdle view, raphe presents two curved lines near the ventral margin of the valve and the two curves meeting over the central nodule, valves 30 µm long, 15 µm in diameter.

Epithemia argus (Ehr) Kuetzing (Fig. 18)

Frustules solitary or in a group, valve arcuate, dorsal side convex and ventral planoconvex, ends rounded, raphe



Figs 13-23: 13. *Cymbella ventricosa* 10 x 40; 14. *Cymbella tumida* 10 x 40; 15. *Hantzschia amfioxys* 10 x 40; 16. *Gomphonema hebridense* 10 x 40; 17. *Gomphonema constrictum* 10 x 40; 18. *Epithemia argus* 10 x 40; 19. *Amphora veneta* 10 x 40; 20. *Amphora coffeaeformis* 10 x 40; 21. *Amphora clevei* 10 x 40; 22. *Cocconeis pseudomarginata* 10 x 40; 23. *Cocconeis dirupta* var *flexella* 10 x 40.

curved, V-shaped on the ventral side. Cells 62 µm long, 12 µm in diameter, costae 3 in 10 µm.

Hantzschia amfioxys (Ehr.) Grunow (Fig. 15)

Valves narrowly linear, lanceolate, dorsal side convex, ventral side slightly concave, with deep median depression, ends slightly attenuated, constricted, rounded capitate, keel punctae distinct thick slightly elongated, medium two set apart, central nodule prominent, striae fine, lineate, parallel throughout the valve. It is 74 µm long, 7 µm broad, striae 18-25 in 10 µm.

Gomphonema constrictum Ehr. (Fig. 17)

Valves broadly clavate, broadly rounded, apex not very large, central area defined with more isolated punctae, raphe thick and straight, striae alternately long and short, valves 45 µm long, 12 µm in diameter, striae 10-12 in 10 µm.

Gomphonema hebridense (Greg.) Her. (Fig. 16)

Valves broadly clavate, axial area not very large, central area defined, median striae not alternately long and short, valves very slender and central area very small. Valves 5 µm in diameter, striae 6 in 10 µm.

DISCUSSION

The present study documents nineteen taxa of high mountainous freshwater algal flora of Garuda Tal. Cyanophyceae was represented by three genera and three species, Chlorophyceae by six genera and five species, Bacillariophyceae by six genera and eleven species; *Rhizoclonium*, *Spirogyra* and *Gomphonema* were abundant, whereas *Oscillatoria*, *Chroococcus*, *Cocconeis* and *Cymbella* were common. Kant and Gupta (1998) have also given detailed taxonomic enumeration of freshwater algae like

Oscillatoria, *Chroococcus*, *Spirogyra*, *Cymbella*, *Gomphonema* and *Cocconeis* from the ponds and streams of Ladakh, Kashmir. Sahin (2003) reported *Cymbella*, *Fragillaria*, *Pinnularia* and *Surirella* as common diatoms, *Oscillatoria* was the common blue-green alga and desmids were the common green algae from the mountain lakes of Eastern Black Sea region, Turkey. Diatoms were numerous in both the Garuda Tal and lakes of Eastern Black Sea. The results obtained from Garuda Tal are similar to the data of Sahin (2003) from the Eastern Black Sea.

Medvedeva (2001) recorded Cyanophyta, Chlorophyta, Bacillariophyta and few taxa of Chrysophyta, Dinophyta and Xanthophyta from temperate benthic communities in Sikhote Alin biosphere reserve in Russia. These forms were also reported by Tolotti (2001) from Adamello Brenta Regional Park in Italy and by Banderas-Tarabay (1997) from lake E Isol in Mexico. We did not encounter algal forms belonging to Chrysophyta, Dinophyta and Xanthophyta from Garuda Tal.

Ever increasing population, agricultural activities and industrial pollution are the main threats to our environment. Garuda Tal is an ideal example of a natural system and it is largely ecologically intact and remote from industrial and agricultural centres of this region. Therefore, algal assemblage of this lake can be of great value in providing base line data for future monitoring and assessing the effects of anthropogenic activities.

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CLUTCH AND BODY SIZE ANALYSIS OF *SPHAEROTHECA ROLANDAE* (ANURA: RANIDAE)[1]

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Clutch size analysis of *Sphaerotheca rolandae* was examined based on eggs obtained from ovaries of females and laid by amplecting females. Clutches of 42 amplecting females were counted. The measurement of snout-vent length (SVL) and weight (WT) of amplecting males and females indicate larger females. The minimum and maximum clutch size of 42 females was 449 and 1037 respectively; there was no correlation between body size and clutch size. Eggs counted from both the ovaries of 18 gravid females suggest that the minimum and maximum clutch size is 1896 and 5472 respectively. Like in amplecting females, the body size is not a factor of clutch size in gravid females. Larger egg counts for gravid females than for amplecting females were due to the presence of immature oocytes in the ovaries of the former.

Key words: Anura, Ranidae, *Sphaerotheca rolandae*, clutch

INTRODUCTION

Reproductive pattern and clutch size of amphibians are relatively well documented for temperate species than tropical ones (Tilley 1968; Bruce 1969; Salthe 1969; Crump 1974; Brockelman 1975). A good deal of information is also available on the annual reproduction of tropical anurans from Southeast Asia (i.e. *Bufo melanostictus* in Java: Church 1960a and in Singapore: Berry 1964; *Rana cancrivora* in Java: Church 1960b; *Rana erythraea* in Borneo: Inger and Greenberg 1963; *Kaloula pulchra*, *Microhyla butleri*, *M. heymonsi* and *Leptobrachium nigrops* in Singapore: Berry 1964; *Limnonectes leporinus*, *R. macrodon* (incertae sedis), *Limnonectes ibanorum* and *R. hosii* in Borneo: Inger and Bacon 1968).

A series of studies by Mohanty-Hejmadi and Dutta (1979); Dutta and Mohanty-Hejmadi (1976); Dutta *et al.* (1991, 1992); Mohanty-Hejmadi and Dutta (1988); Mohanty (1993) and Rath (1994) report the number of eggs per clutch of *Hoplobatrachus crassus*, *H. tigerinus*, *Limnonectes limnocharis* (= *Fejervarya syhadrensis*), *Euphlyctis cyanophlyctis*, *Ramanella variegata* and *Bufo melanostictus*. In this paper, morphometric parameters and clutch size of another member of Ranidae, *Sphaerotheca rolandae* has been described.

MATERIAL AND METHODS

Clutch sizes have been analyzed for both gravid and amplecting females. Amplecting males and females (42) were collected from breeding grounds at night over a period of nine years. They were brought to the laboratory in polythene bags and transferred to glass containers with amphibious environment. Precaution was taken to avoid external disturbances such as light and sound, which interfere with safe egg laying. Immediately after egg laying, the egg clutches were transferred to enamel trays containing conditioned tap water. The snout-vent length (SVL) and weight (WT) of each specimen was measured. The eggs were counted and reared in the laboratory.

To determine the clutch size of gravid females, specimens were collected from their breeding grounds and preserved in 4% formaldehyde. Prior to preservation, they were measured and weighed. A total of 18 gravid females were collected during four years. The preserved specimens were dissected and both the ovaries were removed. The eggs were separated from lobules and staged following Dumont (1972). At least 20 eggs (containing all the available stages) were measured from each clutch to determine the range of ovum size.

Cumulative means, SD, minimum and maximum SVL and weight (WT) of amplecting males and females have been determined from individual parameters. Correlation matrix of SVL and WT of amplecting pairs and clutch sizes has been analysed. Year-wise analysis of morphometric parameters for both males and females, and clutch sizes has been conducted to provide a eomparative statement.

RESULTS

Clutch and body size of amplecting pairs (Tables 1-3): The minimum and maximum SVL and WT of amplecting

Table 1: Cumulative mean, Standard Deviation (SD), minimum and maximum of SVL (mm) and WT (gm) of amplecting males and females and clutch size (N = 42)

	Minimum	Maximum	Mean	SD
SVL (Male)	29.00	38.00	34.004	2.587
WT (Male)	3.80	5.00	4.397	0.435
SVL (Female)	35.00	44.00	39.866	2.192
WT (Female)	5.20	7.90	6.552	0.774
Clutch	449.00	1037.00	754.428	150.742

i. The 't' for SVL of amplecting males and females is 11.381, which is highly significant at 1% level of probability.

ii. Regression relationship between SVL (female) and clutch size. Clutch size = - 0.0463 + 756.1082.

Table 2: Correlation matrix of SVL (mm) and WT (gm) of amplecting males and females and clutch size (refer to Table 1)

	SVL (male)	WT (male)	SVL (female)	WT (female)	Clutch
SVL male	1.000				
WT male	0.748*	1.000			
SVL female	-0.054 NS	-0.038 NS	1.000		
WT female	-0.084 NS	-0.116 NS	0.828**	1.000	
Clutch	0.116	0.298 NS	-0.001	0.058 NS	1.000

NS = Not significant.

* = Significant at 5% level.

** = Significant at 1% level.

females and males are presented in Table 1. Correlation matrix of SVL and WT is presented in Table 2.

Year-wise analysis (Table 3) indicated that females with lowest SVL (35.74 mm) were observed in 1987 and highest (43 mm) in 1992. Males with lowest SVL (30.96 mm) and highest SVL (35.66 mm) were recorded in 1986 and 1991, respectively. Analysis of weight showed the lowest (5.46 gm) and heaviest (7.56 gm) females in 1987 and 1991, respectively. It was interesting to note that the weight of the males was comparable with SVL, as the minimum (3.90) and maximum (4.73) were observed in 1986 and 1991, respectively. The minimum value for mean number of eggs (646.63 ±177.220) was recorded in 1980, and the maximum value for mean number of eggs (918.5 ±19.091) in 1992. This indicated that there was no correlation between mean clutch size and mean SVL or WT of amplecting males and females, because neither males nor females with minimum or maximum mean SVL and WT were recorded during 1980 or 1992.

The mean clutch size of amplecting males and females is 754.428 ±150.742, the minimum clutch size (449) was for the female with 38.0 mm SVL and the maximum clutch size (1037) was for the female with 39.0 mm SVL. However, the smallest female (35.0 mm SVL) laid 820 eggs and the largest female (44.0 mm SVL) laid 932 eggs. This indicates that no correlation exists between the body size and clutch size in this species.

A comparative assessment of SVL of amplecting males and females indicated that the smallest male (29.0 mm SVL) was found in amplexus with a female measuring 40.9 mm in SVL, and the largest male (38.0 mm SVL) amplected with a female measuring 38.0 mm in SVL. Therefore, no correlation exists between SVLs of amplecting males and females. However, all the amplecting males were smaller than the amplecting females. The "t" value for SVLs of amplecting males and females is 11.381, which is highly significant at 1% level of probability.

Clutch and body size of gravid females (Table 4): Interestingly, the largest female (50.0 mm SVL), with the maximum weight (9.3 gm), had the maximum number of oocytes (5472). However, the smallest female (39.0 mm SVL) had more number of oocytes (4048) than several larger females. Data on mean, SD and range of SVL, WT and clutch size is presented in Table 5. Correlation matrix of SVL, WT and clutch, size is given in Table 6.

Table 3: Year-wise mean and Standard Deviation (SD) of clutch size, SVL (mm) and WT (gm) of amplecting males and females

Year	No	SVL (M)	SD	SVL (F)	SD	WT (M)	SD	WT (F)	SD	Clutch	SD
1980	8	33.44	2.678	40.14	1.597	4.57	0.426	6.37	0.730	646.63	177.220
1981	8	35.0	2.035	39.31	1.251	4.64	0.534	6.37	0.561	755.37	206.230
1986	5	30.96	1.494	40.0	1.842	3.90	0.141	6.90	0.703	747.0	132.898
1987	5	34.6	3.111	35.74	0.622	4.40	0.514	5.46	0.151	748.0	102.924
1988	4	33.87	3.567	40.57	0.403	4.65	0.624	6.77	0.330	769.25	161.438
1990	3	34.53	0.503	39.46	1.331	4.23	0.057	5.93	0.513	783.33	158.295
1991	3	35.66	3.214	42.36	1.001	4.73	0.550	7.56	0.251	877.66	114.023
1992	2	32.40	1.272	43.0	1.414	4.10	0.141	7.50	0.565	918.50	19.091
1993	4	35.50	1.249	41.57	1.201	4.20	0.081	7.22	0.287	653.50	97.154

M: Male; F: Female

The clutch size of gravid females was more than that of the amplecting females. This is because the total oocytes present in both the ovaries of gravid females were taken into account. Also, the oocytes of gravid females were at stages I-III and VI, whereas for amplecting females, only mature ova (stages VI) were laid. The size (diameter) of the ovum also varied between the clutches of both the categories. The eggs laid by amplecting females were >1.0 mm in diameter, whereas the eggs of gravid females were <1.0 mm in diameter and in several cases, the egg sizes were <0.5 mm in diameter. This is obviously due to the presence of oocytes of Stage I, II and III in the ovaries.

DISCUSSION

Sphaerotheca rolandae is a seasonal breeder (Das 1995) and reproductive output of seasonal breeding depends only on the number of eggs laid by a female. Several workers (Terentjev 1960 on anurans; Salthe 1969 on salamanders; Matsui and Ota 1984 on anurans) have reported correlation between body and clutch size. Clutch size is generally affected by the mode of reproduction and aquatic species have larger clutch sizes than species dwelling on land (Crump 1974; Duellman and Trueb 1985). No correlation was observed between the body and clutch size of *S. rolandae* and this is also comparable with previous studies on *Hoplobatrachus tigerinus*, *H. crassus*, *Fejervarya syhadrensis* and *Polypepdates maculatus*. Terentjev (1960) first reported the correlation between body size and clutch size of frogs. Inger and Bacon (1968) tested the formula of Terentjev (1960) for studies on *Rana erythraea*, which was significantly below expectation. Terentjev's formula has not been used for clutch size analysis of *S. rolandae*. However, egg clutches of 42 females have been utilized to establish the correlation with SVL, WT and clutch sizes. The gravid specimens were utilized to assess the number of oocytes present in both the ovaries, where as the amplectant specimens were utilized to assess the number of eggs laid. Interestingly, the clutch sizes (ovarian eggs) of gravid females were more than the clutch size (laid eggs) of amplecting females. No such comparative assessment of clutch size of any Indian anuran is available. When the clutch and body size of *S. rolandae* is compared to that of other Indian ranids (*H. tigerinus*, *H. crassus* and *F. syhadrensis*), it is noticed that *H. tigerinus* and *H. crassus* (except *F. syhadrensis*) laid more eggs than *S. rolandae* and their sizes were also comparable with that of Inger and Bacon's (1968) studies on four ranids from Borneo. Hence, it is assumed that in ranids the clutch size increases with the increase of body size between species, but not within a species.

A comparative assessment of clutch sizes of *S. rolandae* with *P. maculatus*, a rhacophorid (Rath 1994) indicates a deviation from the assumption made for ranids i.e. more eggs for larger species. Though *P. maculatus* is a relatively larger species the clutch size of this species is small. This deviation

Table 4: SVL, WT, clutch size, oocyte stages and ovum sizes of gravid females

Year	Gravids	SVL (mm)	WT (gms)	Clutch size	Oocyte stages	Ovum size (mm) range
1989	1	42.0	7.5	2224	I, II, VI	0.391-1.609
	2	45.0	5.8	3176	I, II, VI	0.478-1.304
	3	45.0	5.5	2968	I, II, III, VI	0.478-1.391
	4	46.0	8.9	2912	I, VI	0.347-1.174
	5	45.0	7.5	2460	I, II, VI	0.348-1.131
	6	41.0	7.5	3935	I, VI	0.435-1.304
	7	40.0	7.0	2520	I, II, III, VI	0.478-1.261
	8	50.0	9.3	5472	I, VI	0.348-1.061
	9	44.0	5.2	1896	I, VI	0.478-1.174
	10	45.0	7.9	2846	I, VI	0.435-1.304
	11	39.0	7.3	4048	I, II, VI	0.565-1.261
1991	12	44.0	6.5	3665	I, VI	0.456-1.189
	13	40.0	5.0	2650	I, VI	0.535-1.125
	14	42.5	5.0	2455	I, VI	0.425-1.168
1992	15	43.5	5.2	2022	I, VI	0.478-1.311
	16	44.0	6.5	1950	I, VI	0.460-1.385
1993	17	41.5	5.0	3605	I, VI	0.475-1.235
	18	43.0	5.3	2232	I, VI	0.465-1.165

i. Mean clutch size is 2946.444

ii. Regression relationship between SVL (female) and clutch size: Clutch size = -1106.1250 + 93.461 SVL

Table 5: Mean, Standard Deviation (SD), minimum and maximum of SVL (mm), WT (gm) and clutch size of gravid females (refer to Table 4)

Name	Mean	SD	Minimum	Maximum
SVL	43.361	2.616	39.00	50.00
WT	6.550	1.381	5.00	9.30
Clutch	2946.444	917.628	1986.00	5472.00

Table 6: Correlation matrix of SVL (mm), WT (gm) and clutch size of gravid females (refer to Table 5)

	SVL	WT	Clutch
SVL	1.000		
WT	0.418 NS	1.000	
Clutch	0.266 NS	0.4978*	1.000

NS = Not Significant.
* = Significant at 5% level

could be attributed to the specialized breeding strategy of *P. maculatus*, which lays eggs inside foams and that the embryonic development is completed inside the foams. Thus, *P. maculatus* exhibits indirect parental care for successful reproduction. On the other hand, though *S. rolandae* lays a larger clutch, due to direct egg laying in water, the eggs are subjected to environmental constraints. Thus, the hatching success is reduced like in other ranids. It is interesting to note that all the species with larger body – larger clutch size, unlike *P. maculatus*, have no parental care.

Additional comparative assessment of clutch sizes of *S. rolandae* with other inter-generic species (microhylids: *Uperodon systoma*: (unpublished data) and *Ramanella variegata*: Dutta *et al.* 1992), also suggests variation. Being a larger species than *S. rolandae*, the clutch sizes of *U. systoma* are also larger than *rolandae*. Similarly, *R. variegata* a smaller species than *S. rolandae* has a smaller clutch size. Interestingly, all the above three species live sympatrically and are burrowers. Hence, it is hypothesized that specialized mode of living is also correlated with clutch size.

Several other studies (Kuramoto 1978; Inger and Bacon 1968; Wagner 1965, cited by Duellman and Trueb 1985; Mohanty-Hejmadi and Dutta 1979; Mohanty 1993) have also reported clutch sizes of both tropical and temperate species of ranids. The maximum clutch size of a ranid *R. fuscigula* (15,000 eggs) was reported by Wagner (1965). However, the maximum clutch size known for any anuran is 22,412 for *Bufo melanostictus* (unpublished). On the whole, the clutch size of ranids breeding seasonally and occupying similar habitats is correlated to body size at inter-generic level. Thus, the present study agrees with the interpretation of Salthe and Mecham (1974) who reported "female body size increases phylogenetically within any given mode of reproduction with increase in clutch size".

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THE EPIPLEMINAE (LEPIDOPTERA: URANIIDAE) OF THE KUMAON HIMALAYA[1]

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Fourteen moth species of the subfamily Epipleminae are reported from the Kumaon Himalaya. Of these, nine are new records for the Himalaya west of Nepal. Observations on their ecology are noted. One new species, one new form, four new genera and seven new combinations are proposed.

Key words: Epipleminae, Uraniidae, Lepidoptera, Kumaon, Himalaya

INTRODUCTION

The Epipleminae comprise a group of small moths and are currently placed in Family Uraniidae, although earlier (Hampson 1895, 1896; Barlow 1982; Holloway 1986) they were accorded family rank. The greatest diversity of species is found in hilly parts of the Tropics, while relatively few species are found on the lowlands proper. In the Himalaya, they ascend to at least 2200 m and are generally found in or near forests, rarely on meadows or in degraded areas.

STUDY AREA

The present study was carried out in the outermost range of the Kumaon Himalaya, in the state of Uttaranchal. All except three of the species discussed in this paper were collected or noted in Jones Estate (1500 m), 2 km by road northwest of Bhimtal. Bhimtal lake, in the center of town, lies at 29° 20' 40" N and 79° 36' 16" E in Nainital district.

Two specimens of *Phazaca leucocera* (Hampson) were recorded at Durgapur (1600 m), a suburb of Nainital. A pair of *Dysaethria himalayica* sp. nov. was recorded in Maheshkhan 17 km north of Bhimtal in the Gagar range at 2100 m. The single specimen from Garhwal was taken in a forest near Auli ski resort above Joshimath in Chamoli district at 2100 m.

All these locations except Durgapur are densely forested, with different species of Oak (Fagaceae) as nodal species, *Quercus leucotrichophora* A. Camus in Jones Estate, *Q. leucotrichophora* and *Q. floribunda* Lindley ex A. Camus in Maheshkhan and *Q. floribunda* and *Q. semecarpifolia* Smith in the forest near Auli. In addition, there are stands of *Pinus roxburghii* Sarg., *Cupressus torulosa* D. Don and tropical deciduous species such as *Sapium insigne* Trim., *Bauhinia vareigata* L., *Erythrina suberosa* Roxb., etc. in Jones Estate. Durgapur has a mix of Chir Pine (*Pinus roxburghii*) and miscellaneous deciduous forest, the Oak having been practically eradicated through human agency.

MATERIAL AND METHODS

The present paper is based on specimens recorded by the author. All the specimens examined in this study are from the period after 1990 and are in the author's personal collection at Jones Estate, Bhimtal, Nainital, Uttaranchal.

All the specimens examined, except a pair of *Dysaethria himalayica* and one specimen of *Somwaria restricta* (Hampson) comb. nov. were attracted to artificial light. The main attractants used were mercury vapour lamps of 125 W and 160 W.

The genitalia of the species were not examined. The key diagnostic features for *Dysaethria* Turner and some other genera are to be found in the genitalia (Holloway 1998). However, some external characters are also diagnostic. These, especially the hindwing venation, have enabled me to place species in genera or propose new ones, as discussed in the systematic section.

In the systematic section, the distribution of species has been excerpted from Hampson (1895, 1896) and Holloway (1998). Hampson does not mention forewing length, hence the measurements given are of the specimens examined in this study.

SYSTEMATIC SECTION

Dysaethria reticulata (Moore) comb. nov. (Fig. 1)

1888. *Descr. new Lep. Ins. Colln. W.S. Atkinson*: 259

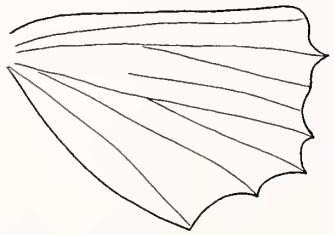

Fig. 1: Hindwing *recto* venation of *Dysaethria reticulata* (Moore) male

Material Examined: **16 exs.,** 30.viii.1995 (bred); 7.viii.1997; 15.viii.1997; 16.viii.1997 x 5; 22.viii.1997; 23.viii.1997; 1.ix.1997; 25.v.1998; 15.vi.1998; 21.vi.2000; 28.viii.2000. 14.ix.2004.

Forewing Length: 9-13 mm.

Expanse: 30 mm (Hampson 1895); 20-30 mm (mihi).

Distribution: Sikkim; Khasis (Meghalaya).

Remarks: A new record for Kumaon. It is well established in the Bhimtal valley, where it is perhaps the commonest member of its Subfamily. It was bred on *Jasminum dispermum* Wallich (Smetacek and Smetacek 2000). It is common around the main study site where there are many plants of *J. dispermum*, over five individuals being attracted in the course of an evening during their peak flying times. Since *J. dispermum* occurs as far west as Kashmir, *D. reticulata* probably occurs west of the Bhimtal valley, but it is not certain how much further west. It does seem unlikely that it occurs in Kashmir.

D. reticulata rests with its head and costae of the outstretched forewings nearly touching the substrate, while its wings and body are held at an angle of roughly 45 degrees to the substrate. The tip of the abdomen and tornal parts of the hindwing thus become the highest parts of the moth above the substrate. This position is adopted irrespective of the plane of the substrate or the direction in which the moth is facing. Usually, the moth takes up this position immediately upon settling, especially if it has been disturbed and forced to rise from its previous perch.

Besides the material examined, this species has been noted to be on the wing continuously from late June to late October, with peak flying times at the end of June, the first week of August and the third week of September.

The material examined matches Hampson's (1895) description. In addition, there is a curved antemedial line on the hindwing and some dark submarginal marks on the forewing between the apex and vein Cu1a. The sexes are similar.

Dysaethria himalayica sp. nov. (Fig. 2)

Material Examined: 4 exs.: **Holotype**: 4.vi.1998, female, Maheshkhan 2100 m, Nainital district. **Forewing Length**: 16mm.

Paratypes: 4.vi.1998, male, Maheshkhan 2100 m, Nainital district; 28.vii.2000, female; 19.xi.2000, female, Jones Estate, Bhimtal. **Forewing Length**: 13-16 mm.

Expanse: 28-34 mm.

Distribution: see under remarks.

Type Locality: Same as Holotype.

Etymology: The specific name refers to the presence of this species in the Himalaya.

Fig. 2: *Dysaethria himalayica* sp. nov.

Diagnosis: Differs from Hampson's (1895) description of *Epiplema moza* Butler in the following points: on the forewing, the three dark submarginal specks below the apex are present, but the lowest speck is expanded into a relatively large lunule; on the hindwing, there is a faintly discernable medial line highly angled at vein M_3 and a dark speck rather than a brown line on the discocellulars; there is a dark, ill-defined submarginal band from vein M_3 to the dorsum. The hindwing has tails at veins M_3 and Rs and is toothed at M_1.

This appears to be the only species of this genus of those examined that displays sexual dimorphism, albeit very slight, in the ground colour of the wings. The colour of the females is darker than that of the males and consequently the markings are clearer in the female.

Remarks: Hampson (1895) treated this species as *Epiplema moza* Butler. Since *moza* is a Japanese taxon and the allied *Dysaethria suisharyonis* (Strand) (from Taiwan) and *Dysaethria subflavida* (Swinhoe) (from Malaya, Java and Borneo) are not known to extend to the Himalaya, it followed that the Himalayan taxon lacked a name; hence the present name is proposed. Material from other locations, i.e. Himachal Pradesh and Meghalaya, from where "*moza*" has been reported (Hampson 1895) has not been examined, but it is likely that *himalayica* is found in Himachal Pradesh. However, material from the Khasi Hills will need to be compared before *himalayica* can be reported with certainty from there.

It is a rather rare moth in the Bhimtal valley. It appears to be a commoner in forests above 1600 m. I have found them settled on the upper surface of leaves of low growing shrubs during the daytime in damp ravines in Maheshkhan. Only two specimens have been recorded so far from the Bhimtal valley, both of them females. There is no information on how far these moths can travel in the course of dispersing the species. Therefore, it is uncertain whether these females were from a small, established population near the main study site or whether they are from a distant population that reached Jones Estate in the course of dispersing the species. It is noteworthy, though, that males have not been recorded so far in Jones Estate, which suggests that the latter possibility is the likelier.

The species appears to have at least two annual generations. It is likely that it will also be found in September at higher elevation, eg. in Maheshkhan, when other species recorded from above 1600 m such as *Dysaethria multistrigaria* (Moore) comb. nov. are also on the wing. The record from November is unusual since few moths are on the wing at that time. It is possible that the specimen recorded is an unusually late specimen rather than a member of a regular pre-winter brood.

The moth spends the daylight hours resting with the wings outspread and pressed flat against the substrate, with no part of the moth raised above the surface. There is a gap between the fore- and hindwings.

Dysaethria multistrigaria (Moore) comb. nov. (Fig. 3)

1888. *Descr. new Ind. Lep. Ins. Colln. W.S. Atkinson*: 260.

Material Examined: 9 exs.: 10.ix.1995; 28.viii.1997; 24.vi.1999; 7.vii.1999; 7.ix.1999; 19.vi.2000; 18.ix.2000; 20.ix.2000; 26.ix.2003.

Forewing Length: 10-12 mm.

Expanse: 26 mm (Hampson 1895); 22-26 mm (mihi).

Distribution: Shimla (Himachal Pradesh); Sikkim.

Remarks: Not a very common species in the Bhimtal valley. It is, however, a regular visitor to the MV light and appears regularly every year. There are at least two annual broods, one beginning in the second half of June and continuing to July and the second in September. Peak flying time is in the second week of July, when six or more individuals may appear in the course of an evening.

Individuals have also been noted in late July (18.vii.1999) and in August (9.viii.1999). It is not clear whether these were stragglers or members of a small brood. The former possibility seems more likely.

This species rests in a manner very similar to that adopted by *D. reticulata*, which is already described under that species. It differs slightly in that the head and costae of the forewings are held further off the substrate.

The specimens examined match Hampson's (1895) description, but some are smaller than the material examined by Hampson.

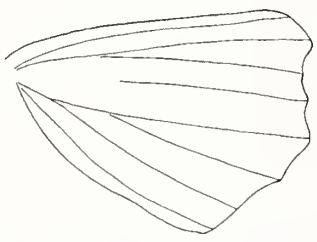

Fig. 3: Hindwing *recto* venation of *Dysaethria multistrigaria* (Moore) male

The record from Shimla indicates that the species will probably also be found at higher elevation, about 2000 m. Its flying time may be more restricted in the higher reaches of its range.

Dysaethria rhagavata (Walker) (Fig. 4)

1861. *Cat. Lep. Het. in Brit. Mus.* 23: 848.

Material Examined: 1 ex.: 7.x.2001 female.

Forewing Length: 13 mm.

Expanse: 28-32 mm (Hampson 1895); 28 mm (mihi).

Distribution: Sikkim, Khasis (Meghalaya), Sri Lanka.

Fig. 4: *Dysaethria rhagavata* (Walker)

Remarks: Only a single specimen has been recorded so far. It might be commoner at lower elevation.

The specimen has been placed under this species tentatively. According to Holloway (1998), *D. rhagavata* is found in Sri Lanka, while a specimen from the N.E. Himalaya (Khasis), in the British Museum (Natural History) in London (? the same on the basis of which Hampson included Khasis in the distribution of *rhagavata*), is probably referable to *D. rhagavolita* Holloway.

The specimen examined in the present study differs from Hampson's (1895) description in lacking the dark triangular mark on the middle of the forewing's outer margin; from his description of typical *rhagavata* it differs on the hindwing in having the post medial line angled at veins M_3 and M_1 and the lunules on the outer margin of the hindwing not extending nearly to the anal angle. In addition, the specimen bears dark blotches on the dorsum of both wings basad of the postmedial lines and the postmedial line on the hindwing originates from a dark mark on the costa.

It is certainly not referable to *rhagavolita*. Hampson noted that some specimens have dark blotches on the inner margins of both wings. Since the present specimen fits this description and there appears to be no name for this form (or possibly species), the name *nigropunctata* nov. is proposed. The type specimen can be the species examined in the present study, since it has been adequately described above. However, its true affinity and status will only emerge when more material is available.

Dysaethria ruptaria (Moore) comb. nov.

1888. *Descr. new. Ind. Lep. Ins. Colln. W.S. Atkinson*: 259.

Material Examined: 5 exs.: 20.ix.1995; 6.ix.1997 female; 4.viii.1999; 9.viii.2000; 26.vii.2003.

Forewing Length: 7-8 mm.

Expanse: Male 16 mm; female 18 mm (Hampson 1895); 16-18 mm (mihi).

Distribution: Dharamsala (Himachal Pradesh); Calcutta (W. Bengal).

Remarks: The smallest member of the genus in the area. This is the first record from the outer ranges of the Himalaya, although its appearance in Calcutta (=Kolkata) suggests that it occurs at all elevations up to 1800 m and throughout the breadth of the Himalaya, at least as far west as Dharamsala, which is in the main range.

It is not a common moth in the Bhimtal valley. There appear to be two annual broods, one in early August and the second in September. There may be more broods at lower elevation.

It rests with the wings outspread, the head and the costae of the forewings touching the substrate, while the remaining part of the forewings slope upwards at an angle of roughly 30 degrees to the substrate. The inner margins of the forewings are thereby raised quite high above the substrate, and are nearly in a straight line when viewed dorsally. The apices of the hindwings also touch the substrate but the remaining portion of the hindwings slope proximally towards the dorsum of the abdomen. Although they do not cover the abdomen, they form a sort of tent with the uncovered abdomen as centre pole.

All the specimens examined match Hampson's (1895) description.

Sylviplema gen. nov.

Type species: *bicaudata* (Moore)

Diagnosis: Similar to *Dysaethria* Turner, but differs in the presence of two anal veins in the hindwing. Vein M_2 is present in the hindwing. The venation and head of the male is illustrated in Hampson (1895: fig. 71). The venation of the female's hindwing is similar to both sexes of *Somwaria* gen. nov. described below.

Sylviplema bicaudata (Moore) comb. nov. (Fig. 5)

1867. *Proc. zool. Soc. Lond.*: 643, pl. 33, fig. 12.

Material examined: 3 exs.: 17.viii.1992 Auli, Chamoli district 2100 m, male; 25.viii.1997 female; 24.vi.2000 female.

Forewing length: 11-12 mm.

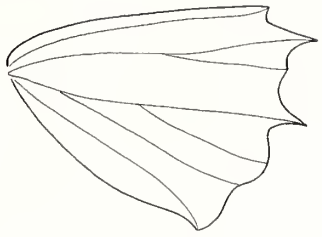

Fig. 5: Hindwing *recto* venation of *Sylviplema bicaudata* (Moore) female

Expanse: 26 mm (Hampson 1895); 24-26 mm (mihi).

Distribution: Dharamsala (Himachal Pradesh); Sikkim; Khasis (Meghalaya).

Remarks: The present records are the first from the outer ranges of the Himalaya west of Nepal. It is a rare species in the Bhimtal valley, but may be commoner in the main range. I have recorded it from Auli in the main range and Dharamsala is also in the main range.

The moth rests in a manner similar to *Somwaria restricta* Hampson comb. nov., which is described below. *S. bicaudata* and *restricta* should perhaps be placed in the same genus, given the similar fascies, resting posture and venation of the female. The male's venation, however, is difficult to reconcile and until some more stable character is discerned, perhaps in the genitalia, it is best to treat them in separate genera.

The specimens match Hampson's (1895) description. There appear to be two annual generations, one in late June and early July and the second in late August.

Somwaria gen. nov.

Type species: *restricta* (Hampson)

Diagnosis: Similar to *Dysaethria* Turner but differs in the absence of vein M_2 on the hindwing. There are no discocellulars on the hindwing and only one anal vein. Venation of both sexes similar, unlike *Sylviplema*.

Somwaria restricta (Hampson) comb. nov.

1895. Faun. Brit. Ind., Moths *3*:130.

Material Examined: 13 exs.: 13.viii.1995; 15.viii.1995; 11.vii.1990; 9.viii.1997 x2; 19.viii.1997 x2; 20.viii.1998; 12.vi.1999; 2.vii.1999; 3.viii.1999; 30.vii.2000; 2.viii.2000.

Forewing Length: 10-11 mm.

Expanse: 26 mm (Hampson 1895); 22-24 (mihi).

Distribution: Sikkim; Nagas (Nagaland).

Remarks: A new record for the Himalaya west of Nepal. It is a common moth in the Bhimtal valley, much more frequently met than *Sylviplema bicaudata*. However, it is doubtful whether it is found in the main range.

In addition to the material examined, individuals of this species were also noted on 8.ix.1999 and 30.ix.1999. There appear to be several overlapping generations in the Bhimtal valley during the monsoon months.

The moth rests with its wings outspread, the inner margin of the forewings held in a straight line, the head and distal half of the forewings pressed to the substrate. The outstretched hindwings are drawn together towards the abdomen, leaving a gap between the fore- and hindwings. The hindwings do not cover the abdomen and, unlike *Dysaethria ruptaria*, do not touch the substrate. Although the hindwings rise tent-like towards the dorsum of the abdomen, both fore- and hindwings are in more or less the same plane, unlike *D. ruptaria*. The body of the moth is held at an angle to the substrate, so that it rises gradually towards the tip of the abdomen, which is the part of the moth furthest from the substrate.

This moth is an agile runner and can run forward or sideways with equal facility. It is a very nervous creature and gets agitated if other insects move about near it, unlike *D. reticulata* and *D. multistrigaria*.

During the daytime, they settle in the position described above on the upper surface of low growing shrubs, especially on overcast or rainy days.

Pangteyia gen. nov.

Type species: *ocusta* (Swinhoe)

Diagnosis: Male with antennae thickened and flattened. Forewing with the outer margin produced to points at Cu1b and M_1; veins R_1 and R_2 stalked, R_1 anatomosing with Sc; hindwing with the costa excised at middle and with a tuft of hair before middle; vein M_2 present; the first anal vein weakly developed along the basal half of dorsum, the second normally developed; the outer margin produced to an oblique tail at vein M_3 and to points at veins Cu1b and Rs.

The genus is named for Y.P.S. Pangtey, former Professor of Botany at Kumaon University, Nainital, in recognition of his many kindnesses over the years.

Pangteyia ocusta (Swinhoe) comb. nov. (Fig. 6)

1894. *Trans. Ent. Soc. Lond.*: 165.

Material Examined: 5 exs.: 9.ix.1998; 10.vii.1999; 12.ix.1999; 26.vii.2000; 21.v.2003.

Forewing Length: 12 mm.

Expanse: 24 mm (Hampson 1895); 26 mm (mihi).

Distribution: Sikkim; Khasis (Meghalaya).

Remarks: A new record for the Himalaya west of Nepal. It is quite a rare moth in the Bhimtal valley. The above records suggest that the moth has at least two and perhaps three annual broods. This in turn suggests that it is better established at some locality within dispersal range of the main study site and the moth is not actually resident in the Bhimtal valley.

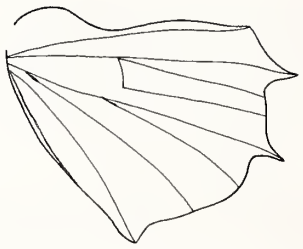

Fig. 6: Hindwing *recto* venation of *Pangteyia ocusta* (Swinhoe) male

The moths examined match Hampson's (1895) description except in the matter of size and that on the forewing *recto* the antemedial line does not expand into a red brown patch. At night, it settles with its wings outspread, rather like *Dysaethria himalayica*. During the daytime, the wings are pressed flat to the substrate and crumpled lengthwise, so that they appear to be corrugated. There is a gap between the tornus of the forewing and the apex of the hindwing.

Himaplema gen. nov.

Type species: *pectinicornis* (Dudgeon)

Diagnosis: Antennae of male bipectinate; outer margin of forewing evenly curved; male with a fovea below base of cell; hindwing produced to points at veins M_3 and Rs; a lobe at base of costa articulating with the retinaculum as well as the frenulum; vein M_2 weakly developed and the costal lobe with a curved veinlet.

Himaplema pectinicornis (Dudgeon) comb. nov. (Fig. 7)

1896. Faun. Brit. Ind., Moths 4: 549.

Material Examined: 12 exs.: 8.viii.1997; 20.viii.1997; 23.viii.1997; 26.viii.1997. 1.ix.1997; 23.v.1998; 14.vii.1999; 3.viii.1999; 9.vi.2002; 27.vii.2003; 5.viii.2003; 23.viii.2003.

Forewing Length: 11-12 mm.

Expanse: 26 mm (Hampson 1896); 24-26 mm (mihi).

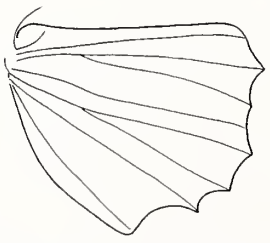

Fig. 7: Hindwing *recto* venation of *Himaplema pectinicornis* (Dudgeon) male

Distribution: Sikkim; Bhutan.

Remarks: A new record for Kumaon. It is well established in the Bhimtal valley. In addition to the material examined above, a specimen was also noted on 23.vii.1999; two on 26.vii.1999; five on 6.viii.1999; three on 12.viii.1999; one each on 22.viii.1999 and 24.viii.1999; two on 25.viii.1999 and one on 26.viii.1999.

It is relatively common in some years, with the peak flying time in August. The record from May is unusual, since it is hot and dry at the time, whereas most members of this subfamily are on the wing only during periods of high atmospheric humidity.

The moth rests with its wings outspread and held against the substrate. There is a gap between the fore- and hindwings not as wide as in *Dysaethria ruptaria*, *Sylviplema bicaudata* and *Somwaria restricta*. It is possible that this moth adopts a different position when resting during the daytime, but this has not been observed so far.

The specimens examined match Hampson's (1896) description. In addition, on the forewing *recto*, there is an indistinct antemedial line and a dark spot on the discocellulars. In some individuals, the submarginal lunulate dark mark below the forewing apex is broken up into two spots, the upper one smaller than the lower one.

Phazaca theclata (Guenée)

1857. *Hist. Nat. Ins. Lep.: Uran. et Phal. 2*: 36.

Material Examined: 1 ex.: 28.x.2003 (male).

Forewing Length: 10 mm.

Expanse: 22 mm (Hampson 1895; mihi).

Distribution: W. Africa; throughout India, Sri Lanka, Myanmar (Hampson 1895); Afrotropical Region, mainland Asia (Holloway 1998).

Remarks: A new record for Kumaon. Almost certainly will be more frequently met at lower elevation. The single specimen recorded is the only one seen so far in the Bhimtal valley.

In the specimen examined, the pale ochreous brown ground colour of the hindwing's distal half extends past the medial line to parts of the proximal half of the wing.

***Phazaca* sp.** of the *unicauda* (Hampson) group

1891. *Illust. Typ. Lep. Het. in the Colln. Brit. Mus. 8*: 103, pl. 150, fig. 21.

Material Examined: 2 exs.: 29.vii.2001 female; 20.vii.2003 female.

Forewing Length: 8 mm.

Expanse: 22 mm (Hampson 1895); 18 mm (mihi).

Distribution: Sikkim; Nilgiris (Tamil Nadu) (Hampson 1895); Indian Subregion (Holloway 1998).

Remarks: The two specimens have not been assigned a species, since the fascies match quite well the illustration of the putative female of *Phazaca unicaudoides* Holloway (1998), (pl. 7, fig. 46), but since the latter is restricted to Borneo, it is better to err on the side of caution until more material is available. The next closest is *unicauda*, but the specimens examined differ in having two short tails on the hindwing, exactly as in Holloway's specimen mentioned above. The remaining differences between Hampson's description and the specimens examined i.e. the reduction of the marginal fuscous lunules on the forewing to a series of specks; the presence of a curved postdiscal line and a short medial spur on the costa, the hindwing with the postdiscal line angled rather than curved and the absence of a marginal lunulate line are perhaps too many to ascribe to sexual dimorphism, since Hampson's description is of a male and the specimens examined are females. Holloway (1998) is also quite clear that the female of *unicauda* lacks the hindwing tails. In addition, the vertex of the head and antennae are brown, not white in the specimens examined.

An examination of males of this species, when they eventually appear, will help resolve the status of this species unequivocally.

Phazaca leucocera (Hampson)

1891. *Illus. Typ. Lep. Het. Coll. Brit. Mus. 8*: 102, pl. 150, fig. 13.

Material Examined: 15 exs.: 18.vii.1995 x2; 25.x.1998; 11.viii.1998 Durgapur, Nainital 1600 m; 20.vii.2003 x3; 21.viii.2003 x5; 26.ix.2003 Durgapur, Nainital 1600 m; 1.ix.2003; 25.xi.2003.

Forewing Length: 9-10 mm.

Expanse: 22 mm (Hampson 1895); 20-22 mm (mihi).

Distribution: Nilgiris (Tamil Nadu); Sri Lanka (Hampson 1895); South India; Hong Kong, Borneo, Solomon Is. (Holloway 1998).

Remarks: A new record for Kumaon. The species is quite common and I have also recorded it from Durgapur. It swarmed in both locations for two weeks from August 10 to 24, 2005, with over 50 individuals settled around each lamp left on in the area.

Both the specimens mentioned by Holloway (1998) are from low elevation, so it is more than likely that this species will be better established at low elevation in Kumaon too.

Specimens appear to emerge sporadically and it is difficult to judge the number of generations of this moth in a year. The record from late October is almost certainly a straggler, but whether it emerged late from its pupa or is a part of a large, regular brood at lower elevation that straggled up is uncertain.

At rest, the forewings are scrolled so that the moth somewhat resembles *Monobolodes* Warren, but the members of the latter genus tend to fold their wings tightly, so that they resemble a twig, while *leucocera* folds them loosely, so that the outer margin is wider than the basal area.

The specimens examined match the description in Hampson (1895).

Warreniplema fumicosta (Warren)

1896. *Ann. Mag. Nat. Hist. (6) 17*: 215.

Material Examined: 3 exs.: 13.v.1998; 22.iv.2001; 21.ix.2003.

Forewing Length: 10 mm.

Expanse: 22 mm (Hampson 1896; mihi).

Distribution: Khasis (Meghalaya); Nagas (Nagaland) (Hampson 1896); N.E. Himalayas, Taiwan, Borneo (Holloway 1998).

Remarks: A new record for Kumaon. It is not common in the Bhimtal valley. There are two annual broods. It has probably been overlooked among the commoner *Monobolodes simulans* (Butler), which looks very similar when settled.

According to Holloway (1998), both Bornean specimens were recorded at 1618 m elevation. Since the Indian records, too, appear to be from hilly areas, the species seems to be a montane one.

The appearance of this moth in Kumaon is unexpected, since it has not been recorded from the Himalaya proper so far. Although the same can be said of *Phazaca leucocera*, it has a wider distribution and its appearance therefore cause less surprise.

The specimens match Hampson's (1896) description perfectly.

Monobolodes simulans (Butler)

1889. *Illust. Typ. Spec. Lep. Het. Colln. Brit. Mus. 7*: 81, pl. 133, figs 6, 7.

Material Examined: 20 exs.: 9.viii.1997; 10.viii.1997 x2; 23.viii.1997; 30.iii.1991; 23.iv.1998; 29.iv.1998; 2.v.1998; 25.v.1998; 7.ix.1998; 23.iv.1998 female; 16.ii.1999; 16.iii.1999 female; 25.ix.1999; 1.x.1999; 2.xii.1999; 28.iii.2000; 21.vii.2003; 20.vii.2003. 30.xi.2003.

Forewing Length: 10-14 mm.

Expanse: 24 mm male, 28 mm female (Hampson 1895); 22-30 mm (mihi).

Distribution: Kangra (Himachal Pradesh) (Hampson 1895); Himalayan (Holloway 1998)

Remarks: A common species in the Bhimtal valley, where it is the only Epipleminae that is on the wing practically throughout the year. In addition to the above records, it has also been noted on 9.xi.2003 and 10.xi.2003. However, it does not seem to be so common in Durgapur, so perhaps it is only locally common.

Some specimens differ from Hampson's (1895) description in lacking the rufous apical patch on the forewing. According to Holloway (1998), in this group of species, the female's hindwing is duller brown than the male's, or even black, with generally less rufous forewings. This difference is evident in the specimens examined, although Hampson does not mention it.

The moth rests with its forewings folded so that they are of almost uniform thickness throughout and bear a remarkable resemblance to a twig. The fold, when viewed from the side, is in the form of a highly stylized figure S, with the costa rolled over until it touches the medial veins and forms a sort of tube while the lower half of the wing is tucked under the tube and resembles the lower half of the figure S. (Fig. 8b). Only the tornus of the forewing touches the substrate. The hindwings are held close to the abdomen. The costa is almost parallel to the abdomen. Near the outer margin, the tips of the medial veins touch the substrate and the lower half of the wing slopes sharply upwards to cover the abdomen. There is an anal fold. The antennae are held under the wings, sometimes trailing out between the wings as illustrated in Fig. 8a. This position is adopted immediately upon settling and it is only very occasionally that the moth is seen for any length of time with the wings expanded to their normal span.

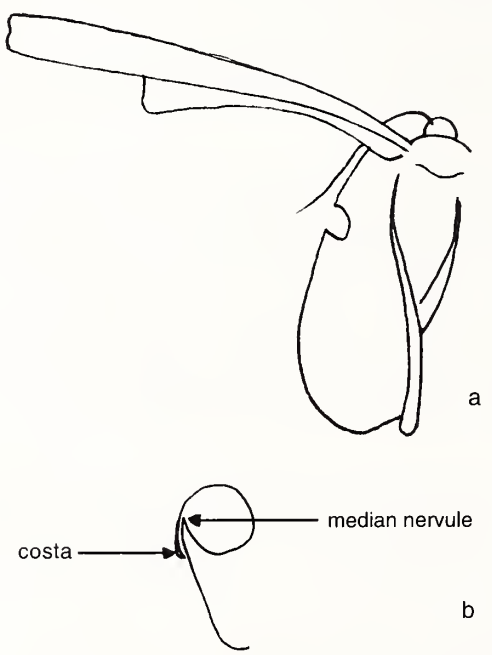

Fig. 8: a. Dorsal view of a resting *Monobolodes simulans* (Butler), b. Lateral view of the folded forewing of *M. simulans* (Butler) showing how the wing is furled

DISCUSSION

Hampson (1895,1896) recorded seven members of Epipleminae from the Himalaya west of Nepal. Of these, five have been recorded in the present study and two, "*Epiplema*" *columbaris* Butler and *Nossa nelcinna* (Moore), have not been recorded. "*E*". *columbaris* appears to be a western Himalayan endemic, the only known records being from Dharamsala and Shimla in Himachal Pradesh (Hampson 1895). It is possible that this moth will be found at higher elevation or in the main range in Kumaon and Garhwal since Shimla is higher than the Bhimtal valley and Dharamsala is in the main range.

The eight new records and one unidentified species in this paper take the total to sixteen species of Epipleminae known from the Himalaya west of Nepal. In addition I have a specimen of *Oroplema* Holloway from Bhimtal, which makes a total of seventeen species. Work on this subfamily has been carried out at only four locations in Kumaon and Garhwal i.e. the main study site in the Bhimtal valley, Durgapur in Nainital, Maheshkhan and Auli forests, so it is more than likely that further new records or even species will appear when other biotypes are properly surveyed.

Of the fourteen species recorded in this study, the status of *Dysaethria rhagavata* form *nigropunctata* is uncertain while the identity of one species, treated under *Phazaca*? *unicauda*, is also uncertain. Of the remaining dozen, eight are endemic to the Himalaya and hills of N.E. India while *D. ruptaria* appears to be restricted to N. India. The two species from the W. Himalayas not recorded in the present study are also Himalayan endemics.

Two species, i.e. *Phazaca theclata* and *P. leucocera*, are widely distributed, the former perhaps the most widely distributed Old World Epiplemine. The distribution of *Warreniplema fumicosta* is particularly interesting, since it is a montane element that has colonized the Himalaya, Taiwan and Borneo. I can think of only one other genus with a similar distribution, *Mahanta* Moore (Limacodidae). However, there are two species of *Mahanta* over this range, with the Bornean species recently discovered and described.

The large percentage of Himalayan endemics is unmatched by any other subfamily or family. However, it should be noted that the geographical distribution of the Epipleminae is far from satisfactorily known and several species may eventually turn out to be more widespread than is currently believed.

Flying time

Broadly speaking, all the species included in the present study are active when relative humidity levels are over 15%. The exception is *Monobolodes simulans*. Peak flying times for most species coincide with the highest annual humidity levels in late June, again in late July and the first week of August and lastly in mid-September. Some species like *D. reticulata* are on the wing continuously through the S.W. Monsoon while others, such as *D. ruptaria* and *P. ocusta*, appear sporadically. It is noteworthy that none of the species except *M. simulans* and *W. fumicosta* are on the wing during the dry winter or dry summer months, i.e. from December to mid-May.

Resting attitude

Watson and Whalley (1983) noted that at rest, the wings of members of this (sub) family are folded in various ways. The hindwing is usually folded along the side of the abdomen while the forewings can be either flat or rolled. Similarly, Barlow (1982) stated that when at rest the forewing is usually held flat against the surface while the hindwing is curiously raised and held partly furled along the abdomen, separate from the forewing.

Holloway (1998) noted that the resting position is sometimes modified, particularly in *Phazaca* Walker, *Monobolodes* Warren, *Warreniplema* Holloway and *Europlema* Holloway. The wings are otherwise (i.e. in *Dysaethria* Turner, *Oroplema* Holloway, *Pterotosoma* Warren, *Leucoplema* Janse, etc.) held flat against, or parallel to, the substrate at rest.

In this study, I have described the resting attitude of most of the species, since not all species adopt the positions described above when settled. It seems that the resting attitude has some taxonomic value. The members of *Phazaca* adopt a similar position, so similar that it is difficult to distinguish *P. ?unicauda* from *P. leucocera*. *W. fumicosta* and *M. simulans* adopt a very similar position too, so similar that it requires close examination to distinguish them, since the characteristic pale areas of *fumicosta* are obscured by the way the wings are held.

The resting attitude of *P. ocusta* is unique among the species studied in this paper. *S. bicaudata* and *S. restricta* have an identical resting position, while *D. reticulata* and *D. multistrigaria* also have quite similar resting positions. *D. himalayica* and *D. rhagavata nigropunctata* have a similar resting position, which Holloway (1998) described as normal for the genus. *D. ruptaria* differs from all the others, but is closest to the other species with a white groundcolour, *S. bicaudata* and *S. restricta*. However, *Dysaethria* is a rather large genus with several sub-groups, so it is only to be expected that the physical structure of the members will vary to some extent, as will, consequently, their resting attitudes.

Some species, i.e. *D. himalayica* and *S. restricta* have been found settled on the upper surface of leaves of low

growing shrubs during the daytime. Presumably, other members of the subfamily, too, pass the daylight hours on such perches. While *himalayica*, *H. pectinicornis*, *P. ocusta*, *D. multistrigaria* and *D. reticulata* are soberly coloured and easily escape attention, *Somwaria restricta*, *Sylviplema bicaudata* and *D. ruptaria* have a white groundcolour which attracts attention. These moths are not known to be chemically protected. All the latter three species have a superficially similar resting attitude. The most obvious offensive, white thing on the upper surface of a leaf in a forest is a bird's dropping and some moths are known to depend on their resemblance to this to avoid unwelcome attention from foraging birds. It would be interesting to discover what factors the white Epipleminae exploit in order to survive the daylight hours.

Flight

The flight is weak and is sustained solely by rapid wingbeats. These moths appear to be incapable of gliding flight. Like the Geometridae, they do not require a "warming up" period before taking wing even at low temperatures; they can take wing as soon as they are disturbed. However, the flight is generally not of long duration.

ACKNOWLEDGEMENTS

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NEW DESCRIPTIONS

SALARIAS RETICULATUS (PISCES: BLENNIDAE), A NEW FRESHWATER BLENNY FROM CHALAKUDY RIVER, KERALA (SOUTH INDIA)[1]

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Genus *Salarias* Day (1878) has been recorded from the freshwaters of the Indian subcontinent for the first time with the description of a new species *Salarias reticulatus* from the Vettilappara region of Chalakudy river system, Kerala (southern India). The new species can easily be diagnosed by the distinct variations in morpho-meristic characters and colour pattern from species hitherto described. The species name is derived from its reticulated colour pattern.

Key words: *Salarias reticulatus* sp. nov., Blennidae, Chalakudy river, Vettilappara

INTRODUCTION

Family Blennidae comprises five genera accommodating 30 species; all the genera are distributed in Indian waters (Day 1878). Among the five genera, *Salarias* (Cuvier) has the greatest number of species, i.e. 18. Members of the genus *Salarias* can be differentiated from other related genera by the wide gill openings, single row of movable teeth in the jaws and by the absence of a sucker beneath the lower jaw (Day 1878). Hitherto there is no record of blennies from the freshwaters of the Indian subcontinent. While investigating the fish fauna of Chalakudy river system, we came across a single specimen of blenny, whose morphometric and meristic characters were found to be totally different from species hitherto described. We have, therefore, described it as a new species.

MATERIAL AND METHODS

The type locality of the new species is Vettilappara, Chalakudy river, Kerala, South India between 10° 17' 32" N and 76° 34' 66" E. Morphometric measurements were recorded with dial callipers to the nearest millimetre, and expressed as proportion of standard length. Meristics were counted following Talwar and Jhingran (1991).

Holotype: Deposited in ZSI Kozhikode, Regn. No.: ZSI (WGRS) CLT. No. V/F 13031. 100.71 mm SL, Vettilappara, Chalakudy river, Kerala, India, 26.i.2001.

Paratype: None.

Diagnosis: Elongated, body with irregular reticulations and circular interspaces, oblong mouth, strong pectoral girdle and leathery skin. Ventrals jugular, having two flexible spines. A moderately long fringed supraorbital cirrus, a simple cirrus at nape and another short one at the posterior rim of the nostril, with 6 filaments at its base. No crest on the head and the pre-opercle has a posterior projection.

Description: (based on a single specimen with 100.71 mm SL.) (Fig. 1)

D.xii, 15; P.14; V.2; A.18; C.12.

Ventral profile of body more convex than dorsal. Length of head 4.84, of pectoral 5.72, of caudal 5.23, height of body 6.00 times in the total length. Body depth 4.9 in standard length. Eyes high up, diameter 5.2 in head length and 20.6 in standard length. Diameter of eye less than snout length (1.1) and head length (5.2), but higher than inter-orbital width (0.52). Snout length 18.5 and inter-orbital width 32.9 in standard length. Head depth 1.2 in head length, width of the snout a little higher than the post-orbital length (0.96). A single row of incisor-like movable teeth on each jaw and a strong posterior canine on each side of the lower jaw. Gill openings continuous from one side of the head to the other, across the ventral surface of the head. Branchiostegal rays six.

Fins: Dorsal fin with 12 spines and 15 rays, deeply notched, the first lower than the second, which is nearly ½ of body height, while posteriorly it does not extend to the caudal fin. Length of dorsal 1.38 in standard length and 1.71 in TL. Length of pectoral fin 0.97 in head length and 3.8 in standard length.

Length of pelvic fin 6.00 in standard length (SL) and 7.4 in TL. Origin of anal fin opposite to origin of second dorsal fin. Distance from pelvic to anal 3.06 in SL. Caudal fin with 12 rays, middle rays posteriorly branched. Pre-anal length 1.9 in SL and pre-dorsal 4.36 in SL. Lateral line complete, forming an angle beyond 8th dorsal spine. Scales totally absent.

Colouration: Head blackish, body and fins, except ventral, reticulated with brown lines enclosing circular or irregularly formed spaces. Reticulation more prominent on

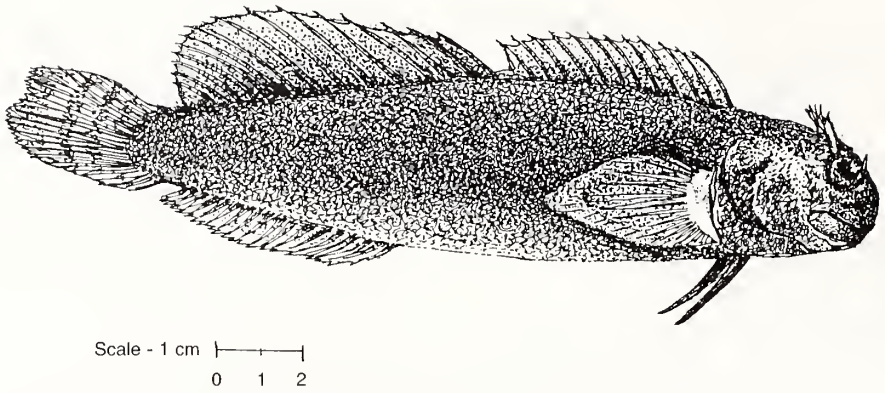

Fig. 1: *Salarias reticulatus* sp. nov. - Lateral view

lateral and ventral sides. Ventral side from snout tip to origin of anal fin whitish without any prominent markings. Ventral fin hyaline with blackish tinge.

Etymology: The specific name is derived from the reticulus pattern on the dorsal side.

Remarks: *Salarias reticulatus* sp. nov. shows close similarity with *S. vermiculatus* and *S. marmoratus*, but differs strongly from them in most of the morphometric characters and meristic counts, namely number of caudal rays and ventral spines, length of head to total length, height of the body to total length, presence of supra-orbital cirri, position of the anal fin and colour pattern (Table 1).

Table 1: Comparison of morphometric and meristic characters of *Salarias reticulatus* sp. nov., *S. vermiculatus* and *S. marmoratus*

Characters	*S. reticulatus* sp. nov.	*S. vermiculatus*	*S. marmoratus*
1. Number of caudal rays	12	11	11
2. Number of ventral spines	2	2	3
3. Length of head to total length	4.85	5-5.5	4.75
4. Pectoral length to total length	5.72	5.5	-
5. Caudal length to total length	5.23	6	7.5
6. Height of the body to total length	6.00	5-5.5	5.5
7. Length of supra-orbital cirri	Longer than eye diameter	Longer than eye diameter	Equal to eye diameter
8. Position of the anal fin	Opposite to second dorsal	A little in advance of second dorsal	-
9. Colour pattern	Body and fins except ventrals reticulated	Body and fin reticulated with brown line	Brownish yellow

Day (1889) described Family Blennidae with 7 genera and 37 species. Of these, 25 were described from India under the genus *Salarias* (Cuvier 1817). De Beaufort and Chapman (1951) described 20 species under the genus *Salarias* from the Indo-Australian Archipelago. However, *Salarias marmoratus* described by Day (1878) was not given independent status by these authors and the specimens collected from Sri Lanka were treated as a synonym of *E. eplazeochilos*. *S. marmoratus* of Gray was synonymised under *Entamocordus lighti*, *E. decussates*, *E. caudofasciatus* and *E. striatus*. Similarly, a change in the generic status of *S. vermiculatus* was also made by describing it as *Entamocordus vermiculatus*. The new species *S. reticulatus* shows distinct variation from *S. sinuosus* (De Beaufort and Chapman 1951) and *S. perioptlialmus* (De Beaufort and Chapman 1951) in most of the morpho-meristic characters such as the number of dorsal and anal fin rays, colour pattern and in the nature of attachment of anal fin rays with the caudal peduncle. According to Munro (1955), Family Blennidae accommodated 8 genera and 16 species, whereas Fischer and Bianchi (1984) described 98 species from the western Indian Ocean in 29 genera under this family. Pillay (1929) reported four species, namely *Salarias steindachaeri*, *S. kirki* *S. bilitonensis* and *S. unicolor* from the coastal waters of Travancore. However, hitherto there has been no report on the occurrence of *Salarias* species in freshwaters of India. The description of a new species of blenny from the Vettilappara region of Chalakudy river in the present study increases the number of species of this family from 98 to 99 and also supports Day's (1878) view that some blennies can extend their geographical range of distribution to fresh water. According to him, this peculiar distribution pattern happens due to the migration undertaken by these species upstream during heavy floods, against the floodwaters, in the monsoon months, and a sudden subsidence thenceforth may result in their being trapped in isolated pools on the mainland. Those

fish which can survive in the new habitat will later reach their original habitat along with subsequent floodwaters.

ACKNOWLEDGEMENTS

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EUONYMUS KANYAKUMARIENSIS - A NEW SPECIES OF CELASTRACEAE FROM INDIA[1]

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Euonymus kanyakumariensis (Celastraceae), a new species resembling *E. pendulus* Wall. from the Mahendragiri Hills in the Western Ghats of Tamil Nadu is described and illustrated.

Key words: Celastraceae, *Euonymus kanyakumariensis* sp. nov., *E. pendulus*, Mahendragiri, Western Ghats, Tamil Nadu

INTRODUCTION

Euonymus L. (*c.* 177 species) of Celastraceae, found in Tropical and subtropical Asia and America, is estimated to have 32 species in India (Lawson 1872; Gamble 1918; Blakelock 1951; Ramamurthy 2000). According to Ramamurthy (1983), 6 species are recorded in Tamil Nadu and 4 from the Tirunelveli Hills (both Tirunelveli and Kanyakumari districts). Botanical collections (1996-2000) from the Tirunelveli Hills at the southernmost end of the Western Ghats, India, yielded a taxon very different from the previously known Indian species of *Euonymus* L. It is described here as a new species.

Euonymus kanyakumariensis C. Murugan and V.S. Manickam sp. nov. (Fig. 1) *E. pendulo* Wall. arte affinis, sed foliis ad marginem integris (in ille serratis), petiolis *c.* 0.5 cm longis (in ille 2-3 cm longis), stipulis glabris (in ille hirsutis), sepalis ad marginem integris (in ille fimbriatis), staminibus petalis curtioribus (in ille longioribus) et lobis capsularum 5, integris, non alatis (in ille 3-4, acute / angulatis et alatis) differt.

Type: India, Tamil Nadu, Kanyakumari district, Mahendragiri Hills, on the way to Parvatham, *c.* 1,400 m, 28.iii.1999. C. Murugan 18741 (Holotype: XCH; Isotype XCH and MH).

Shrub - small tree, *c.* 3 m tall; branchlets obscurely 4-angular; internodes 2-6 cm long. Leaves decussate, rarely ternate, elliptic-oblong, 3-7 x 1.5-3 cm, membranous, base acute, margin entire, recurved, apex obtusely acute; nerves 5-7 pairs, obscure above, prominent beneath; petioles up to 5 mm long, hemispherical; stipules glabrous. Inflorescence axillary, of dichotomously branched cymes, to *c.* 6 cm long; peduncles 3-4 cm long. Flowers 7-9, *c.* 1.5 cm diameter, bisexual, 5-merous, actinomorphic; pedicels 5-10 mm long, slender; bracts subulate, 1-2 mm long, sub-persistent. Sepals 5, imbricate in bud, subequal, sub-orbicular, 2-3 mm diameter, persistent, entire at margin. Petals 5, orbicular, 3-4 mm diameter, greenish-purple, base slightly clawed, margin crispate, apex rounded. Stamens 5, opposite to sepals, shorter than petals; filaments obscure; anthers 2-celled, deltoid. Disc flat, 5-lobed. Ovary 1-2 mm long, 5-celled, immersed in disc; ovules 2 in each, collateral; style subulate; stigma simple, acute. Capsule obcordate, *c.* 2 x 1.5 cm, pink, apex retuse, base acute; lobes 5, towards base, obtuse; seeds 5-10, *c.* 7.5 mm long, brown to black, yellow arillate.

Ecology: Rare in evergreen forests at *c.* 1,400 m.

Fl. & Fr.: March.

Distribution: Known only from Mahendragiri Hills of Kanyakumari district, southern Western Ghats, India.

Etymology: The species is named after the type locality: Kanyakumari district, southern Western Ghats, India.

Note: This new species differs from *Euonymus pendulus* Wallich as shown in Table 1.

Table 1: Comparision of *Euonymus pendulus* Wallich and *E. kanyakumariensis* sp. nov.

Character state	*E. pendulus* Wall.	*E. kanyakumariensis* sp. nov.
Leaf margin	serrate	entire
Petioles	2-3 cm long	up to 0.5 cm long
Stipules	hairy	glabrous
Sepals' margin	fimbriate	entire
Petals	white	greenish-purple
Stamens	as long as petals	shorter than petals
Capsules	3-4 lobed, sharply angular, winged	5 lobed, entire, not winged

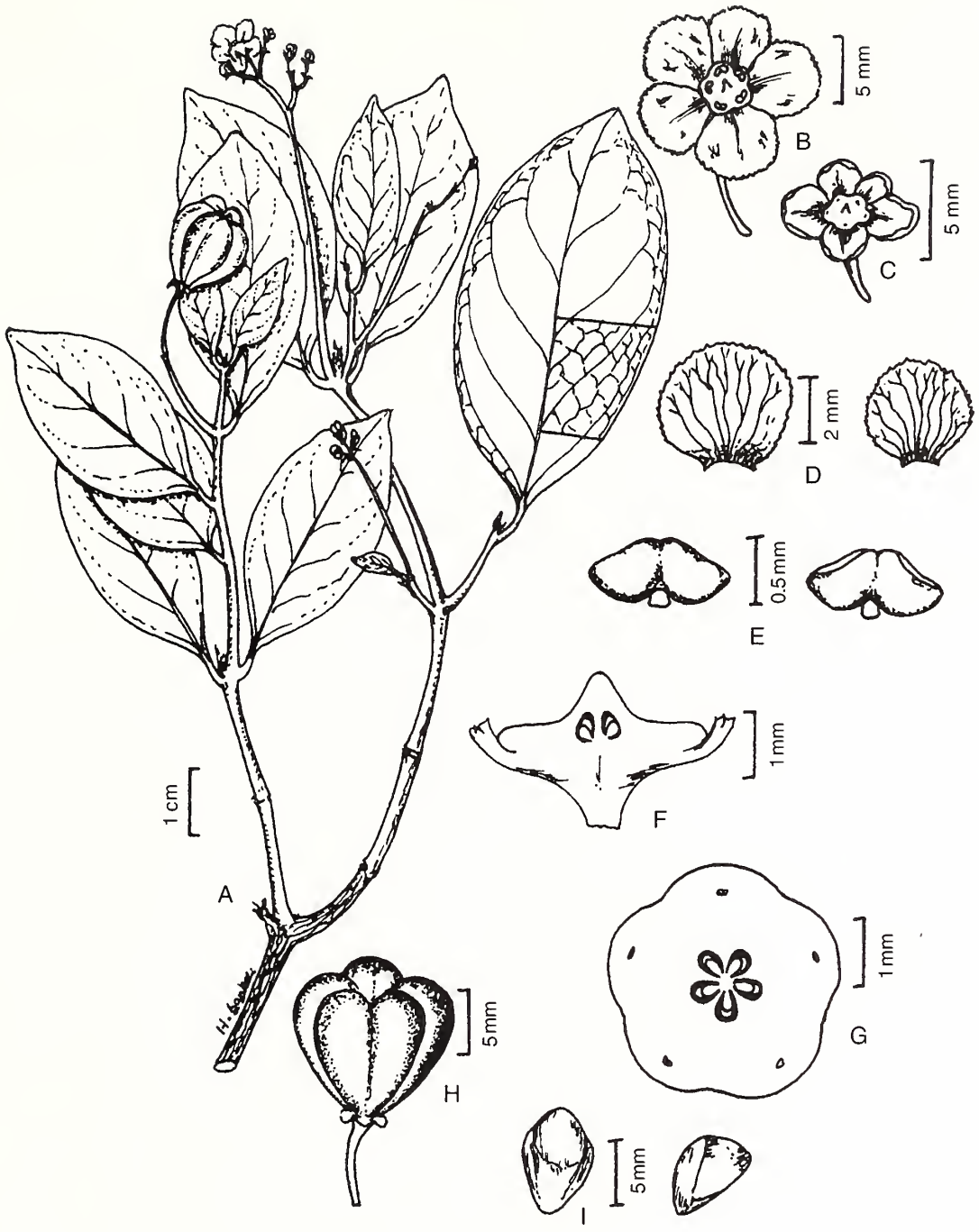

Fig. 1: *Euonymus kanyakumariensis* sp. nov.
A. Twig; B. Flower; C. Calyx; D. Petals; E. Stamens; F-G. Ovary (l.s and c.s.);
H. Capsule; I. Seed

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Our heartfelt thanks are due to Dr. G.V.S. Murthy, Joint Director, Botanical Survey of India (BSI), Coimbatore for permission to use the herbarium and library. We also thank the University Grants Commission (No.F.3-39/96), New Delhi for financial assistance; the Forest Department, Tamil Nadu for allowing us to undertake field studies; Dr. V.J. Nair, BSI Coimbatore for the Latin diagnosis; H. Sankar, CBB, St. Xavier's College, Palayamkottai for the illustration. We are grateful to Dr. K. Ramamurthy and Dr. R. Gopalan, Botanical Survey of India, Coimbatore for their generous help.

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A NEW SISORID CATFISH OF THE GENUS *GLYPTOTHORAX* BLYTH FROM MANIPUR, INDIA[1]

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Glyptothorax ventrolineatus – a new sisorid catfish is described from the Chindwin basin of Manipur, India. The new species has the following combination of characters: three longitudinal light bands on the body – one on mid-dorsal line, one on lateral line and one on mid-ventral line; nasal barbel length twice the internasal length; supra-occipital process not in contact with first dorsal pterygiophore; its width 38.3-44.7% of its length.

Key words: *Glyptothorax*, new species, Manipur

INTRODUCTION

Fish of the genus *Glyptothorax* Blyth are small to medium sized catfishes belonging to Family Sisoridae, which is a composite assemblage of divergent forms. The genus is characterised by its greatly depressed head, thick and papillated lips and an adhesive apparatus with or without a central pit on ventral surface of the thorax (Jayaram 1979). *Glyptothorax* is widespread in South Asia: from Tigris-Euphrates basin eastward to Vietnam and eastern China. There are more than fifty valid species, most of which have restricted geographical distribution (Kullandar *et al.* 1999). Hora (1921) described *G. minutus* from Imphal stream near Karong, and reported the occurrence of *G. dorsalis* Vinciguerra in Manipur Valley and Myanmar. Menon, A.G.K. (1954a) described *G. manipurensis* from the Barak river at Karong of Manipur, and reported the occurrence of *G. trilineatus* Blyth and *G. platypogonoides* Bleeker in the state.

Iril river is a principal tributary of the Imphal river, which in turn joins the Chindwin river in Myanmar. Lokchao river is also a tributary of the Chindwin drainage system. A collection of fishes from the rivers included specimens of *Glyptothorax*, which do not fit into the hitherto described species of the genus. The new fish is described here.

MATERIAL AND METHODS

Measurements and counts follow Jayaram (1999). Measurements were made with a dial calliper to the nearest 0.1 mm and expressed in percentage of standard length (SL) or head length (HL). The specimens are deposited in the Manipur University Museum of Fishes (MUMF).

Glyptothorax ventrolineatus sp. nov.

Material Examined: **Holotype**: MUMF L0221, 85.8 mm SL; Iril river, Ukhrul district, Manipur, India, 15.i.2003, I. Linthoingambi. **Paratypes**: MUMF L0222/5, 5 exs., 85.1-94.5 mm SL; data same as holotype; MUMF 4300/4, 4 exs., 67.2-83.2 mm SL. Lokchao river, Moreh, Chandel district, Manipur, India, 10.iv.2003, K. Nebeshwar and party.

Diagnosis: A species of *Glyptothorax* with three longitudinal light bands; one each along mid-dorsal line, lateral line and mid-ventral line of the body. Surface of head, body and adipose dorsal fin granulated. Length of nasal barbel twice internasal length. Supra-occipital process not in contact with first dorsal pterygiophore; its width 38.3-44.7% of its length. Adipose dorsal fin base length equals rayed dorsal fin base length. Caudal fin longer than head length.

Description: D.I, 6; P.I, 9; V.I, 5; A. iii, 9; C. 7+8. Body elongate, compressed posteriorly. Head depressed, occipital process twice as long as broad, not in contact with first dorsal pterygiophore. Mouth terminal, transverse, eyes small. Barbels four pairs. Maxillary barbels basally thick, distally tapering, reaching posterior base of pectoral fins; mandibular barbel reaches anterior margin of pectoral fin base; inner mandibular equal to interorbital; nasal length twice that of internasal, reaching anterior margin of orbit. Supra-occipital process 38.3-44.7% of its length, not in contact with first dorsal pterygiophore. Teeth villiform in crescentic band in jaws. The thoracic adhesive apparatus is longer than broad, open caudally, without a central pit. Rayed dorsal fin base almost twice head length, (44.4-48.1% of head length); its origin midway between tip of snout and adipose dorsal origin; dorsal spine finely serrated on tip, laterally; base of rayed dorsal equals that of adipose dorsal; adipose dorsal base 37.1-45.4% of interdorsal distance. Pectoral fin low, horizontal, with a broad, flattened, posteriorly serrated spine, does not reach origin of pelvic fin. Pelvic fin length 69.7-79.9% of head length, may or may not reach anal fin. Anal fin 57.7-69.6% of head length; its origin opposite anterior base of adipose dorsal, nearer to pelvic fin origin than to caudal fin base. Caudal fin longer than head length, deeply forked, lobes sub-equal, the lower lobe being the longer. Least height of caudal peduncle

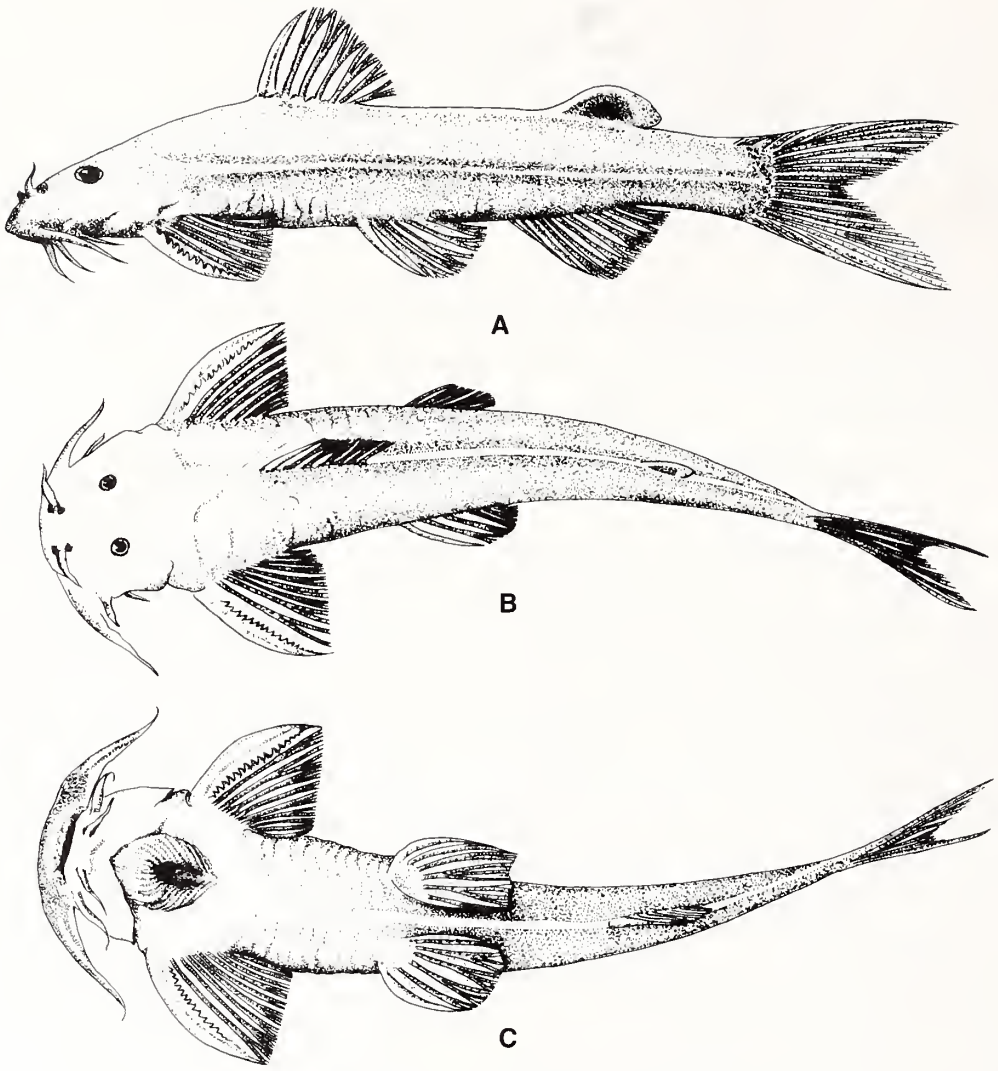

Fig. 1: *Glyptothorax ventrolineatus* sp. nov.
A-Lateral, B-Dorsal and C-Ventral views

46.3-55.4% of its length. Surface of head, body and adipose dorsal fin granulated. Lateral line complete. Morphometric data of the specimens are given in Table 1.

Sexual dimorphism: Unknown.

Colour: Dark brown or greyish, abdomen and underside of head creamish. Anal, pectoral and ventral fins creamish, dorsal base dark brown, a row of light stripes on the rays except the tips of the fin rays. Three creamish longitudinal light bands on the body – one on the back, one on the lateral line and one on the mid-ventral part of the body.

Etymology: The species is named after its characteristic light mid-ventral band.

Distribution: INDIA: Iril river, Ukhrul district, Manipur (Chindwin basin); Lokchao river, Moreh, Chandel district, Manipur.

Discussion: The new species of *Glyptothorax* under description has three characteristic longitudinal bands on the body, which makes it close to *G. trilineatus*. Hora (1923) quoted Blyth's (1860) description of *G. trilineatus* and described the characteristic longitudinal bands of the species to be one on the mid-dorsal line, and one each on the lateral line. Menon, M.A.S. (1954) also followed suit. Hora (1923), however, remarked that such type of colouration is shared among some of the other members of the genus. The Indochinese species *G. laoensis* Fowler, as diagnosed by Kottelat (1998), also has similar lines. Day (1878) recognised the characteristic bands to be one each on the back, lateral line and ventro-lateral area. Subsequent workers (Menon, M.A.S. 1954; Misra 1976; Jayaram 1979; Talwar and Jhingran 1991; Jayaram 1999) also adopted the same. Thus, hitherto known characteristic bands for the species are one each on the dorsal, lateral line, and ventro-lateral area.

Table 1: Morphometric data of *Glyptothorax ventrolineatus* in % of SL and HL, except SL, in mm

Characters	In % Standard Length Mean (Range) ± S.D.	In % Head Length Mean (Range) ± S.D
Standard Length	(67.2-87.0)	—
Head Depth (at occiput)	14.1(12.5-15.5) ±1.0	61.2(57.5-66.3)±3.5
Head Depth (at eye)	9.7(8.8-11.1) ±0.8	42.0(39.5-46.3) ±2.8
Head Width (at nares)	13.4(12.3-14.5) ±0.9	60.3(55.5-63.0) ±3.4
Max. Head Width	19.1(18.5-21.0) ±3.9	85.4(82.7-90.6) ±2.6
Snout length	11.1(10.06-11.9) ±0.6	48.0(45.6-49.3) ±1.2
Eye Diameter	2.3(2.06-2.6) ±0.2	10.2(9.2-11.2) ±0.8
Inter-orbital space	7.5(6.5-8.2) ±0.5	32.8(29.9-37.5) ±2.4
Gape Width	9.8(9.1-10.7) ±0.5	42.7(40.4-45) ±1.7
Internarial Space	3.9(3.8-4.2) ±0.1	17.3(16.0-18.7) ±0.8
Body Width (at dorsal origin)	17.0(15.6-18.3) ±1.05	72.2(71.0-74.2) ±2.9
Body Width (at anal origin)	10.9(9.6-12.6) ±1.08	47.4(40.4-54.4) ±4.2
Caudal peduncle length	18.3(17.0-19.9) ±1.08	79.5(73.1-88.7) ±6.6
Caudal peduncle height	9.6(9.2-10.3) ±0.4	41.9(38.5-46.7) ±2.8
Dorsal fin base length	10.6(10.3-11.1) ±0.2	46.08(44.4-48.1) ±1.5
Length of adipose fin	10.5(9.3-11.1) ±0.6	45.8(40.4-48.7) ±2.6
Length of pectoral fin	22.8(21.4-24.0) ±0.9	104.3(100.5-108.7) ±3.9
Length of ventral fin	17.4(16.6-18.5)± 0.6	75.7(69.7-79.9) ±4.5
Length of anal fin	14.4(13.8-15.8) ±0.7	62.5(57.7-69.6) ±4.1

Thus, *G. ventrolineatus* sp. nov. differs from *G. trilineatus* in having a longitudinal light band on the mid-ventral line of the body vs. no band; nasal barbel length twice internasal length vs. equal; width of occipital process 38.3-44.7 vs. 25.0-33.3% of its length; dorsal spine smooth posteriorly, finely serrated laterally at tip vs. finely serrated posteriorly at tip, smooth laterally.

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THREE NEW SPECIES OF *FIPPATALEYRODES* SUNDARARAJ AND DAVID (ALEYRODIDAE: HEMIPTERA) FROM WESTERN GHATS OF SOUTH INDIA[1]

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The Whitefly genus *Fippataleyrodes* Sundararaj and David was represented in India, so far, by two species. Three new species of *Fippataleyrodes*, namely *F. cinnamomi*, *F. multipori* and *F. yellapurensis*, breeding in the Western Ghats of southern India, have been described here. A key to the Indian species of the genus is given.

Key words: Aleyrodidae, *Fippataleyrodes*, new species

INTRODUCTION

Sundararaj and David (1992) erected the genus *Fippataleyrodes* for the Whitefly species *F. indicus* Sundararaj & David and *F. litseae* Sundararaj & David with the former being the type species. In the present study, we collected five species of whiteflies of genus *Fippataleyrodes* breeding in the Western Ghats of southern India, of which three were new species. The new species are described and illustrated. A key to the Indian species of the genus *Fippataleyrodes* is given.

1. *Fippataleyrodes cinnamomi* sp. nov.
(Figs 1-4)

Material examined: **Holotype**: India: Karnataka: Kumargiri, one puparium, on *Cinnamomum malabatrum*, 10.ix.2001, A.K. Dubey, deposited in the collections of Forest Entomology Museum, Forest Research Institute, Dehradun, India. **Paratype**: One puparium, data same as holotype, deposited in the collections of Natural History Museum, London, United Kingdom.

Description

Puparium: White, without secretion of wax; oval, broadest at metathoracic region, 1.92-1.96 mm long, 1.54-1.62 mm wide; found singly on the under surface of leaves. Margin smoothly crenulate, 32-33 crenulations in 0.1 mm; thoracic and caudal tracheal pore areas not differentiated from margin. Anterior and posterior marginal setae present.

Dorsum: Dorsum completely tuberculate, fine tubercles in between the large tubercles. Cephalothorax with six pairs of tubercles on submedian area – three pairs on prothorax in a group, one pair on mesothorax and two pairs on metathorax, seven pairs of tubercles laterad of abdominal segment III-VIII, in which third abdominal segment with two pairs of tubercles. Longitudinal moulting suture reaching margin and transverse moulting suture reaching subdorsum. Submarginal lines evident, two to three faint broken lines running from cephalus to posterior caudal region on submarginal area. Submedian pockets with depressions present on all the cephalothoracic and abdominal segment sutures. Median length of abdominal segment VII (76 µm) longer than VIII (60 µm). Pockets on eighth abdominal segment not discernible.

Chaetotaxy: Cephalic setae 2 µm long, first abdominal setae 15 µm long, eighth abdominal setae cephalolaterad of vasiform orifice 14 µm long and caudal setae absent. Eight pairs of short capitate setae arranged in a tier- two pairs on cephalothorax (one pair each on mesothorax and metathorax) and six pairs on abdomen (one pair on second abdominal segment and one pair each on abdominal segments IV-VIII), 20 µm long. Vasiform orifice cordate, notched at caudal end, 44-45 µm long, 45-46 µm wide; operculum subcordate, 32-33 µm long, 30-31 µm wide. Thoracic tracheal furrows absent while caudal tracheal furrow indicated, which is incomplete at caudal end.

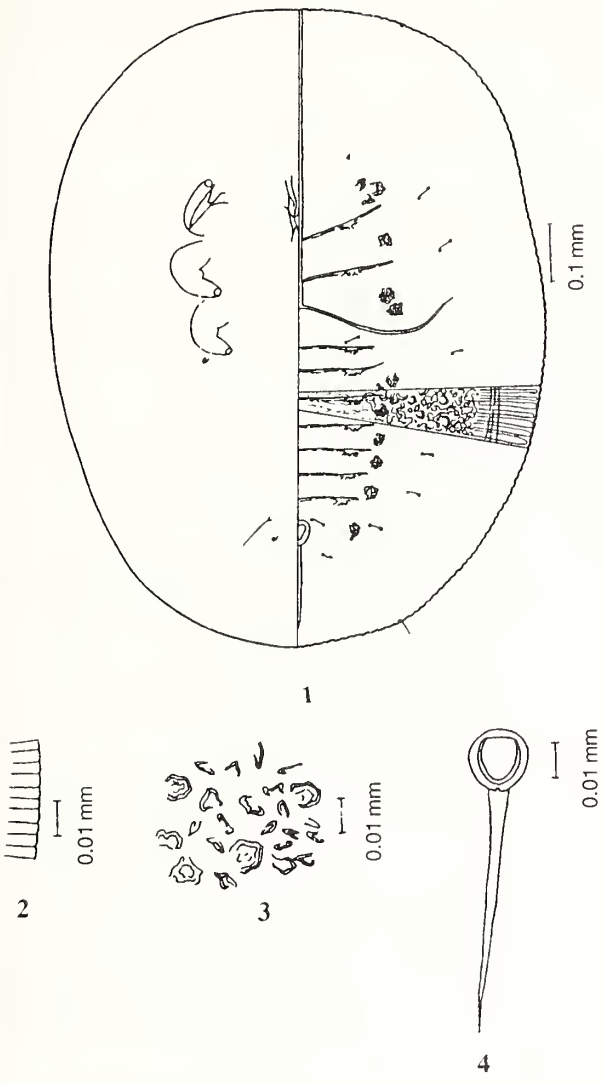
Venter: Paired ventral abdominal setae 25 µm long, 60-76 µm apart. Thoracic and caudal tracheal folds absent. Antennae reaching base of prothoracic legs.

Host: *Cinnamomum malabatrum*.

Distribution: India: Karnataka.

Etymology: Named after its host plant genus *Cinnamomum*.

Comments: This species resembles *F. litseae* Sundararaj & David in the presence of submedian tubercles on cephalothorax and abdomen, and subdorsal capitate setae, but differs in having more number of subdorsal capitate setae, distinct tuberculate dorsum, notched vasiform orifice and incomplete caudal furrow.



Figs 1-4: *Fippataleyrodes cinnamomi* sp. nov.,
1. Puparium, 2. Margin, 3. Tubercles, 4. Vasiform orifice

2. ***Fippataleyrodes indicus*** Sundararaj & David

Fippataleyrodes indicus Sundararaj & David 1992. *Reichenbachia 29(40)*: 16-20.

Material examined: INDIA: Karnataka: Kudremukh National Park, 6 puparia, on *Nothopegia* sp., 12.viii.2001, A.K. Dubey; Goa: Kulem, 9 puparia, on *Litsea* sp., 9.viii.2001, A.K. Dubey. (Specimens deposited in the collections of Institute of Wood Science & Technology, Bangalore).

Hosts: *Litsea* sp., *Nothopegia* sp. (Sundararaj and David 1992).

Distribution: INDIA: Tamil Nadu (Sundararaj and David 1992), Goa, Karnataka (new distribution record).

3. ***Fippataleyrodes litseae*** Sundararaj & David

Fippataleyrodes litseae Sundararaj & David 1992. *Reichenbachia 29(40)*: 16-20.

Material examined: INDIA: Karnataka: Kudremukh, 10 puparia, on *Litsea* sp., 11.viii.2001, A.K. Dubey.

Hosts: *Litsea stocksii* (Sundararaj and David 1992), *Ficus racemosa, Hyduocarpus alpina, Litsea glabrata, Rapanea wightiana* (Meganathan and David 1994), *Litsea* sp.

Distribution: INDIA: Maharashtra (Sundararaj and David 1992), Kerala (Meganathan and David 1994), Karnataka (new distribution record).

4. ***Fippataleyrodes multipori*** sp. nov.
(Figs 5-9)

Material examined: **Holotype**: INDIA: Karnataka: Bandipur National Park; one puparium, on unidentified plant, 11.x.2002, A.K. Dubey, deposited in the collections of Forest Entomology Museum, Forest Research Institute, Dehradun, India. **Paratype**: One puparium, data same as holotype, deposited in the collections of Natural History Museum, London, United Kingdom.

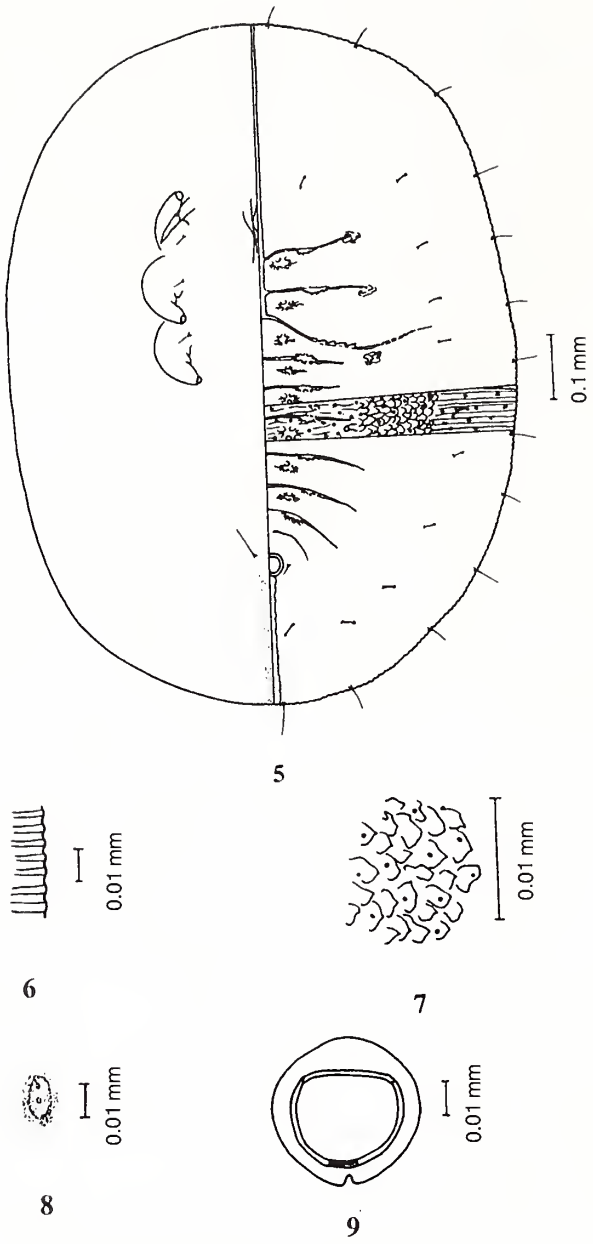
Description

Puparium: White, with secretion of white wax; oval, broadest at first abdominal segment; 2.04-2.07 mm long, 1.56-1.60 mm wide; found singly on the under surface of leaves. Margin crenulate, crenulations in 0.1 mm; thoracic and caudal tracheal pore areas not differentiated from margin.

Dorsum: Tassellated. Longitudinal moulting suture faintly discernible on submargin and merging with submarginal lines and transverse moulting suture merging with tassellations on subdorsum. Submarginal lines evident. Submedian pockets on cephalothoracic and abdominal segments slightly discernible while submedian depressions on all the segments prominent.

Chaetotaxy: Cephalic and first abdominal setae fimbriate, 9µm long, eighth abdominal setae pointed, cephalolaterad of vasiform orifice 14 µm long and caudal setae 49-62 µm long. A pair of minute setae cephalolaterad of caudal setae present, 10 µm long. Subdorsum with a row of eight pairs of fimbriate setae, three pairs on cephalothorax, one pair each on pro-, meso- and metathorax and five pairs on abdomen, 7-10 µm long. A row of 12 pairs of setae present on submargin, 29-40 µm long. Vasiform orifice subcordate, 48-50 µm long, 54-72 µm wide, slightly notched at caudal end; operculum subcordate, 28-29 µm long, 34-38 µm wide. Tip of lingula exposed and included. Thoracic tracheal furrows absent while caudal tracheal furrow indicated with sculptures or tassellations, 396 µm long, 56 µm wide at its widest end.

Venter: Paired ventral abdominal setae 34 µm long, 58-60 µm apart. Thoracic tracheal folds not indicated, while



Figs 5-9: *Fippataleyrodes multipori* sp. nov., 5. Puparium, 6. Margin, 7. Tassellation, 8. Dorsal pore, 9. Vasiform orifice

caudal tracheal fold indicated with stipples. Antennae reaching base of prothoracic legs. A pair of minute setae at base of pro-, meso- and metathorax present, 6 µm long. A pair of minute setae at base of rostrum 9 µm long.

Host: Unidentified plant.

Distribution: INDIA: Karnataka.

Etymology: Named to reflect its distinct pores and porettes scattered on dorsum.

Comments: This species resembles *F. litseae* Sundararaj & David in the presence of subdorsal setae, but differs in shape and in the presence of submarginal setae, distinct pores and porettes on dorsum and absence of submedian row of papillae.

5. *Fippataleyrodes yellapurensis* sp. nov.
(Figs 10-12)

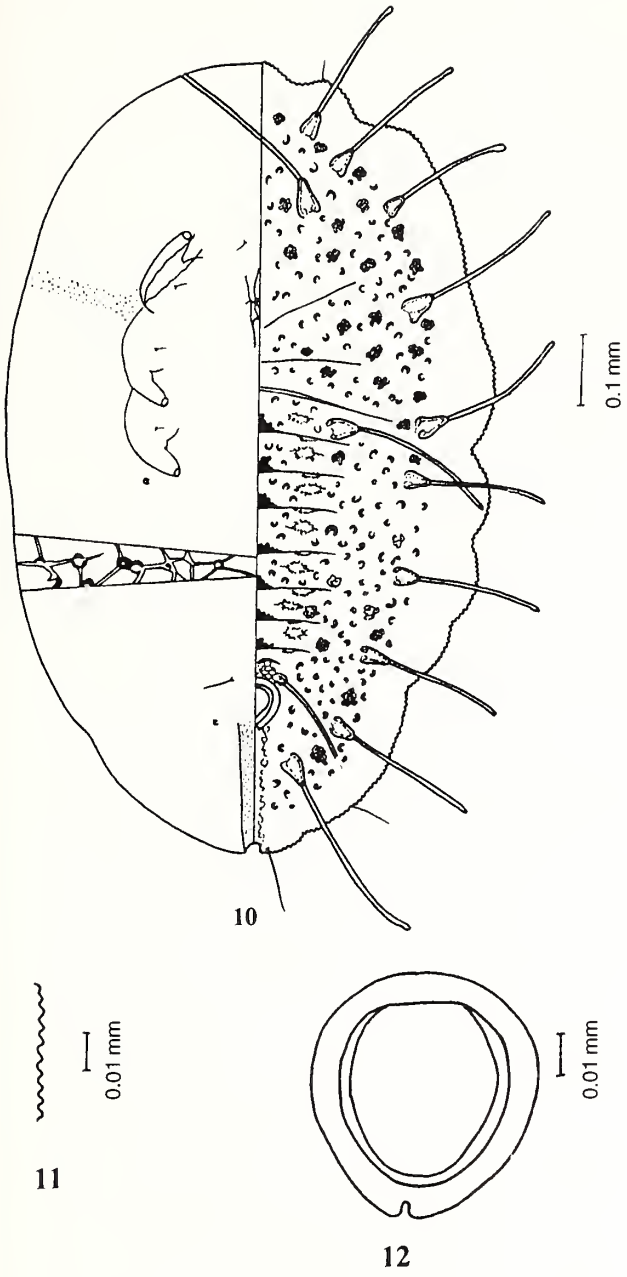
Material examined: **Holotype**: INDIA: Karnataka: Yellapur, one puparium, on unidentified plant, 11.x.2001, A.K. Dubey, deposited in the collections of Forest Entomology Museum, Forest Research Institute, Dehradun, India. **Paratypes**: 8 puparia, data same as holotype, deposited one each in the collections of Australian National Insect Collection, CSIRO Entomology, Canberra, ACT, Australia; Natural History Museum, London, United Kingdom; Indian Agricultural Research Institute, New Delhi, India; National Museum of Natural History, Tel Aviv University, Israel; National Taiwan University, Taipei, Taiwan 107, Republic of China; Staatliches Museum fur Tierkunde, Dresden, Germany; Systematic Entomology Laboratory, U.S. Department of Agriculture, Beltsville, Maryland, USA; Zoological Museum, Universitetsparken, Department of Zoology, Denmark.

Description

Puparium: White, without wax secretion; elongate oval, widest across the first abdominal segment; 0.96-1.26 mm long, 0.60-0.86 mm wide; found singly on the under surface of leaves. Margin irregularly crenulate, 24-30 crenulations in 0.1 mm; thoracic tracheal pore regions not indicated while caudal tracheal pore region indicated by deep invagination. Anterior and posterior marginal setae 35 µm and 42 µm long respectively.

Dorsum: Tuberculated, mostly crescent-shaped and scattered in irregular manner. Submarginal area free from tubercles. Median tubercles on abdominal segments I-VII distinct. Longitudinal moulting suture not discernible. Transverse moulting suture reaching outer submedian area. Submedian pockets present on all the abdominal segment sutures. Submedian depressions present on all the abdominal segments. Pores and porettes not discernible.

Chaetotaxy: Dorsum with four pairs of capitate setae with distinct bases - cephalic setae 304 µm long, first abdominal setae 312 µm long, eighth abdominal setae cephalolaterad of vasiform orifice, 106 µm long and caudal setae 60 µm long. Subdorsum with 10 pairs of long capitate setae arising from distinct subtriangular bases – 5 pairs each on cephalothorax and abdomen, 126-242 µm long. Vasiform orifice subcircular, 62-76 µm long, 58-78 µm wide, notched at caudal end; operculum subcordate, 41-52 µm long, 38-51 µm wide; filling orifice and obscuring lingula. Thoracic tracheal furrows not indicated while caudal tracheal furrow faintly indicated.



Figs 10-12: *Fippataleyrodes yellapurensis* sp. nov., 10. Puparium, 11. Margin, 12. Vasiform orifice

Venter: Paired ventral abdominal setae 35 µm long, 26-36 µm apart; caudal and thoracic tracheal folds with stipples, stipples in thoracic tracheal folds extending up to prothoracic legs. A pair of minute of setae at base of pro-, meso- and metathoracic legs, 6 µm long. Antennae reaching base of prothoracic legs.

Host: Unidentified plant.

Distribution: INDIA: Karnataka.

Etymology: Named after its collection site, Yellapur.

Comments: This species resembles *F. litseae* Sundararaj & David in having tuberculate dorsum and capitate setae, but differs in the presence of long and less number of subdorsal setae and median tubercles on abdominal segments.

KEY TO THE INDIAN SPECIES OF *FIPPATALEYRODES*

1. Abdominal segments without median tubercles; cephalic and first abdominal setae short 2-37.5 µm long 2
— Abdominal segments with median tubercles; cephalic setae 304 µm and first abdominal setae 312 µm long .... *yellapurensis* sp. nov.
2. Submarginal setae pointed 3
— Submarginal setae absent, if present capitate 4
3. A row of submedian papillae present; submargin with 12 pairs of setae; dorsum with distinct pores .... *multipori* sp. nov.
— A row of submedian papillae absent; submargin with 14 pairs of setae; dorsum without distinct pores .... *indicus* (Sundararaj & David 1992)
4. Submargin with 8 pairs of setae; caudal tracheal pore not indicated; vasiform orifice notched at caudal end; caudal furrow incomplete ..... *cinnamomi* sp. nov.
— Submargin with 13 pairs of setae; caudal tracheal pore indicated; vasiform orifice not notched at caudal end; caudal furrow complete .... *litseae* (Sundararaj & David 1992)

ACKNOWLEDGEMENTS

We are grateful to Dr. K.S. Rao, Director, Institute of Wood Science and Technology, Bangalore for the facilities provided. Thanks are due to Prof. B.V. David, President, Sun Agro Biotech Research Centre, Porur, Chennai and Prof. C.A. Viraktamath, Department of Entomology, University of Agricultural Science, GKVK, Bangalore, for their valuable comments. Financial assistance provided by the Ministry of Environment & Forests, Government of India, for conducting this research work, is also gratefully acknowledged.

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■ ■ ■

DESCRIPTION OF A NEW SPECIES OF THE GENUS *NEOCLARKINELLA* REMA & NARENDRAN (HYMENOPTERA: BRACONIDAE) FROM INDIA[1]

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A new species of the genus *Neoclarkinella* Rema & Narendran namely *N. punctata* Ahmad sp. nov. is described from India.

Key words: Hymenoptera, Braconidae, Microgastrinae, *Neoclarkinella*, new species, India

INTRODUCTION

The genus *Neoclarkinella* was erected by Rema and Narendran (1996) to accommodate *N. nilamburensis* as its type species. It can be easily distinguished from its closely related genus *Clarkinella* in having large and triangular scutellar lunule, fore wing without areolet, transverse carinae of propodeum not forming a fork on either side of spiracle and hypopygium striate along median line. The genus is known only from its type species. In the present work, a new species is described from India.

Abbreviations used: OOL - ocello-ocular line (distance from outer edge of lateral ocellus to compound eye); POL - post-ocellar line (distance between inner edges of two lateral ocelli); AOL - anterior-ocellar line (distance between inner edges of anterior and lateral ocellus), ZDAMU- Zoology Department, Aligarh Muslim University.

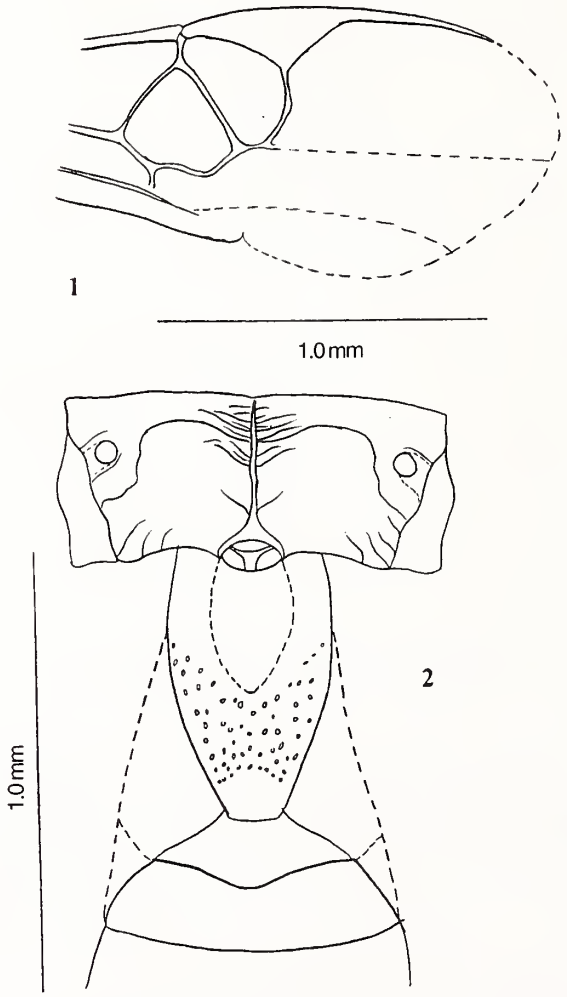
Neoclarkinella punctata sp. nov.
(Figs 1-2)

Material Examined: **Holotype**: ♀, INDIA: Uttar Pradesh, Etawah; 30.iv.2002, Coll. M. Shamim, deposited in the collections of ZDAMU (Catalogue No. HB. 1029); **Paratypes**: 7♀♀, 3♂♂, data same as holotype.

Description

Female: Length 2.6 mm; fore wing length 3.0 mm. Body black except for the following: T1, labrum, mandible, palpi, fore legs, mid legs, hind legs; scape beyond extreme apex and basal depressed area of T1 yellowish; antennae and posterior half of clypeus testaceous, wings hyaline, pterostigma and venation brown.

Head: In anterior view oval in shape; clypeus indistinctly punctuate; malar space about as long as basal width of mandible; face about as long as wide, indistinctly punctuate with hairs, with a faint median longitudinal node; frons concave, smooth and shiny; occiput smooth; temple and



Figs 1-2: *Neoclarkinella punctata* sp. nov. ♀
1. Fore wing 2. Propodeum, T1 and T2

vertex indistinctly punctate; OOL 0.75x as long as POL; POL 3.5x as long as AOL; antennae longer than the body length.

Mesosoma: About 2x longer than wide; mesoscutum depressed posteriorly at imaginary course of notauli, strongly punctate with hairs and punctures become rather sparse posteriorly; scutellum rather sparsely punctate with hairs; mesopleuron medio-posteriorly smooth, rest of the area coarsely punctate; propodeum covered with white pilosity, surface dull with a strong mid longitudinal carina and transverse carina at basal one-third, remaining parts with few cranulae. Fore wing with densely and evenly pilosity in whole; pterostigma 3.3x longer than wide; R1 1.3x as long as pterostigma; r 1.2x as long as r-m, and 1.1x as long as width of pterostigma, r 1.2x as long as m-cu; 2RS 1.2x as long as r. Hind wing with vannal lobe slightly convex and sparsely hairy, 2r-m present. Hind coxae large, virtually smooth with an indistinct punctation; hind tibia 1.1x longer than hind femur.

Metasoma: T1 3.8x as long as wide and strongly tapered apically, basal half with broad U-shaped depressed area and apical half punctuate with hairs; T2 subtriangular, smooth and posterior margin convex; hypopygium about half as long as metasoma, desclerotized, folded and striate medially; ovipositor sheaths 0.61x as long as hind tibia, slender, pointed at apex, and hairy all along length.

Male: Same as female except length (2.45 mm).

Host: Unknown

Distribution: INDIA: Uttar Pradesh.

Etymology: The specific name is derived from Latin, and refers to the punctate sculpture of T1.

Remarks: *Neoclarkinella punctata* sp. nov. closely resembles the only known species of *Neoclarkinella* – *N. nilamburensis* (Sumodan & Narendran), but differs in having T1 punctate apically (T1 smooth apically in *N. nilamburensis*) and antennae testaceous (antennae black in *N. nilamburensis*).

ACKNOWLEDGEMENT

We thank Professor M. Hayat for reviewing the manuscript and for useful suggestions.

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■ ■ ■

A NEW NEMACHEILINE FISH OF THE GENUS *SCHISTURA* McCLELLAND (CYPRINIFORMES: BALITORIDAE) FROM MANIPUR, INDIA[1]

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A new species, *Schistura minutus* is described from the Iyei River, a tributary of the Irang River (Barak drainage), in Manipur, India. The species is characterised by its small size, processus dentiformes not prominent and lying open; 14-18 colour bands on body; a distinct cup shaped colour band just behind occiput; upper lip very thin; deep median interruption in lower lip and absence of a notch in the lower jaw and caudal peduncle deeper than its length.

Key words: new nemacheiline fish, *Schistura minutus*, Manipur

INTRODUCTION

Fishes of the genus *Schistura* McClelland are small sized hill stream fishes characterised by having lower lip medially interrupted, but not forming two triangular pads; a black bar (sometimes dissociated) on caudal fin base; dorsal fin with one or two black marks along its base (Kottelat 1990; Vishwanath and Laishram 2001). Six species of *Schistura* have been described from Manipur, namely *S. manipurensis* (Chaudhuri 1912), *S. kangjupkhulensis*, *S. prashadi* and *S. sikmaiensis* (Hora 1921), *S. reticulata* (Vishwanath and Nebeshwar 2004) and *S. khugae* (Vishwanath and Shanta 2004b). Also, Menon (1987) reported the occurrence of *S. peguensis*.

The Iyei River originates in the Tamenglong district of Manipur and flows southwest to join the Irang River, a tributary of Barak River (Brahmaputra drainage). A collection of fishes from the river included 11 specimens of *Schistura*, which do not fit into the hitherto described species of the genus. The fish is described as new here. Counts and measurements followed Kottelat (1990). The holotype and one paratype are deposited in Zoological Survey of India (ZSI) Kolkata and 9 paratypes, in the Manipur University Museum of Fishes (MUMF), Imphal (Manipur).

Schistura minutus sp. nov. (Fig. 1)

Material examined: **Holotype**: FF3749 ZSI, Kolkata, 35 mm SL, Iyei river, Noney, Tamenglong district, Manipur, M. Shanta Kumar and K. Nebeshwar, 27.xii.2000. **Paratypes**: 1 ex., 32 mm SL, FF3750, 9 exs., 26.2-38.3 mm SL, MUMF 1001-1003, 1005-1006, 1008-1011, Iyei River, Noney, Tamenglong district, Manipur, M. Shanta Kumar and K. Nebeshwar, 27.xii.2000.

Diagnosis: A species with the following combination of characters: small body size; presence of weakly developed processus dentiformes; 14-18 blue black bars on body, mostly in pairs; the basal caudal bar interrupted, represented by two spots; a distinct cup shaped band just behind the occiput; incomplete lateral line; caudal peduncle deeper than its length.

Description: D. iii, 8½; P. i, 8-9; V. i, 6; A. ii, 5½; C. 9+8. A small moderately elongate nemacheiline with body depth almost uniform from the occiput to the base of the caudal fin. Body moderately deep, with 14-18 lateral bars. Ventral profile almost straight from mouth to caudal base, dorsal region of head is highly curved, straight behind dorsal region. Body cylindrical to slightly compressed anteriorly, more compressed in caudal peduncle region. Cheeks slightly inflated, head slightly depressed, snout moderately pointed. Mouth ventral,

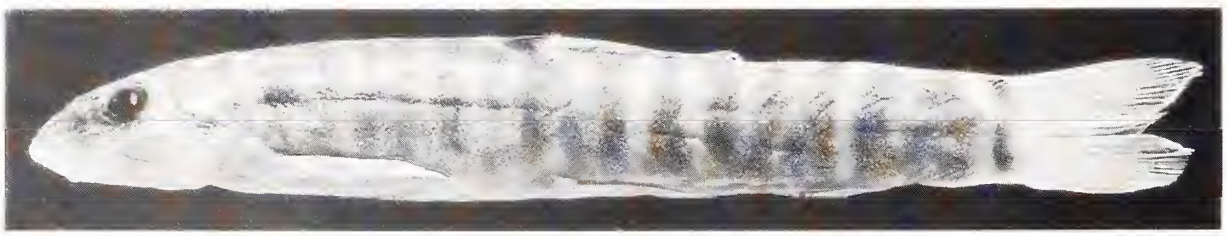

Fig. 1: *Schistura minutus* sp. nov.

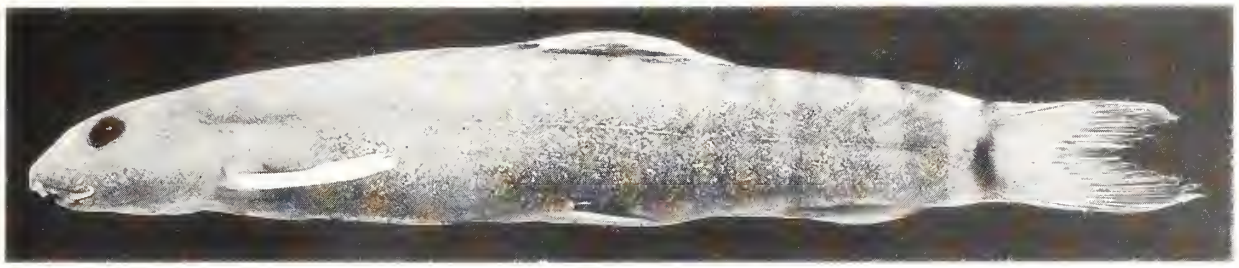

Fig. 2: *Schistura sikmaiensis*

crescent shaped. Upper lip very thin with no incision or furrows. A deep median interruption in lower lip, no median notch in the lower jaw. Processus dentiformes poorly developed. No suborbital flap in male. Barbels small, but longer than eye diameter, maxillary barbels extend up to middle of orbit. Anterior nostrils pierced in front of a flap like

Table 1: Comparison of morphometric characters of *Schistura minutus* with *S. dubia* and *S. sikmaiensis* (in % of SL) except TL, SL and caudal peduncle depth by length

	S. minutus	*S. dubia*	*S. sikmaiensis*	*S. sikmaiensis*
	Mean (Range) ± S.D. (FF 3749, 3750 & MUMF 1001-1003, 1005-1006,1008-1011) N = 11	Mean (range) ± S.D. (Kottelat 1990)	Mean (Range)) ± S.D. (MUMF 1012-1015) N = 4	(Kottelat 1990) N = 1 neotype
Standard length	(26.2-38.3)	(35.3-58.0)	(37.3-43.4)	58.7
Total length	(31.7-44.7)	(119.4-125.7)	(46.1-53.9)	122.5
Dorsal head length	22.0(20.3-24.5)±1.1	-	19.5(18.5-20.1)±0.69	21.1
Lateral head length	24.5(23.2-26.2)±0.89	26.5(23.8-27.8)±0.94	23.6(23.3-24.0)±0.34	24.5
Predorsal length	51.2(49.4-55.0)±1.57	55.3(53.6-56.4)±0.80	50.2(49.8-50.7)±0.41	53.5
Prepelvic length	54.4(51.2-56.4)±1.51	54.3(52.6-55.9)±0.86	53.8(53.4-55.0)±1.13	58.8
Preanus length	72.1(68.8-75.7)±2.34	70.2(68.6-72.4)±0.93	72.3(70.2-73.5)±1.55	77.9
Preanal length	77.6(74.2-79.9)±1.78	77.8(76.2-80.4)±1.07	79.0(78.2-79.9)±0.75	80.8
Post dorsal length	46.0(42.8-49.3)±2.29	-	49.7(49.5-50.0)±0.17	-
Head depth (at eyes)	11.1(10.3-12.4)±0.58	11.1(10.0-12.1)±0.60	10.9(10.2-12.0)±0.78	12.8
Head depth (at nape)	13.7(12.7-14.5)±0.62	13.2(12.2-14.2)±0.44	13.1(12.6-13.6)±0.44	14.7
Body depth	17.5(16.1-22.9)±1.9	17.6(15.0-20.5)±1.24	18.6(18.0-19.5)±0.73	17.6
Depth of caudal peduncle	12.8(11.5-13.7)±0.59	13.7(12.7-14.9)±0.56	12.5(11.9-13.0)±.0.46	12.3
Length of caudal peduncle	11.0(8.4-12.0)±0.97	13.4(12.1-14.3)±0.69	14.1(14.0-14.2)±0.07	12.6
Caudal peduncle depth by Length	116.6(112.1-125.6)	-	0.86(0.84-0.88)±0.02	-
Body width (dorsal origin)	13.6(12.5-16.1)±0.92	13.7(10.5-16.0)±1.40	15.0(14.7-15.7)±0.42	14.0
Body depth (anal origin)	7.9(6.8-8.6)±0.57	8.5(7.6-9.7)±0.58	9.6(9.1-10.0)±0.34	9.0
Height of dorsal fin	15.5(14.5-16.8)±0.69	14.9(12.9-18.1)±1.52	14.2(13.8-14.6)±0.34	14.0
Dorsal fin base length	15.7(15.0-16.8)±0.69	-	15.5(14.9-16.6)±0.74	-
Length of upper caudal lobe	20.6(18.6-22.5)±1.15	22.0(20.2-25.7)±1.52	24.1(23.4-25.2)±0.41	21.0
Length of lower caudal lobe	21.1(19.4-21.8)±0.76	22.9(20.7-25.7)±1.25	22.3(21.7-22.5)±0.75	23.0
Length of median caudal ray	15.1(13.8-17.2)±1.01	18.7(16.4-20.8)±1.19	15.2(14.8-16.3)±0.71	13.5
Height of anal fin	15.9(14.7-16.6)±0.65	17.9(16.2-19.4)±0.89	12.0(11.5-12.6)±0.48	16.7
Length of anal fin	7.5(6.8-8.9)±0.59	-	8.0(7.6-8.3)±0.34	-
Length of pelvic fin	16.0(14.8-17.2)±0.61	17.2(15.6-19.5)±1.02	17.8(17.2-18.7)±0.64	17.2
Length of pectoral fin	18.4(16.7-19.7)±0.88	19.3(17.2-22.9)±1.45	20.1(19.1-21.1)±0.84	19.3

tube, nostrils nearer to eye than to snout tip. Eyes small. Axillary pelvic lobe present. Pelvic fin origin under last simple or first branched dorsal fin rays. Distal margin of the fin slightly convex. Caudal fin emarginate.

Small ventral and dorsal adipose crests on caudal peduncle which is 1.16(1.12-1.25) times higher than long. Largest specimen recorded is 38.3 mm SL. Incomplete lateral line with 23-55 pores, extending up to the region between the pelvic and anal fin origins. Cephalic lateral line system with 7 supraorbital, 4+11 infraorbital, 9 preoperculo-mandibular and 3 supratemporal pores. The abdominal region is greatly inflated in gravid female due to presence of large sized eggs. The body depth and body width show great variation.

Proportional measurements (in percentage): Body depth 17.5 (16.1-22.9); dorsal head length 22.0 (20.3-24.5); predorsal length 51.2 (49.4-55.0); dorsal fin height 15.5 (14.5-16.8); dorsal fin base length 15.7 (15.0-16.8); pectoral fin length 18.4 (16.7-19.7); ventral fin length 16.0 (14.8-17.2); anal fin height 15.9 (14.7-16.6); anal fin base length 7.5 (6.8-8.9); caudal fin length 20.4 (18.5-22.1); caudal peduncle length 11.0 (8.4-12.0); depth of caudal peduncle 12.8 (11.5-13.7); preventral length 54.4 (51.2-56.4); preanus length 72.1 (68.8-75.7); preanal length 77.6 (74.2-79.9); and body width (Dorsal origin) 13.6 (12.58-16.1) of SL. Head width (at opercula) 69.4 (64.7-71.7); head height at occiput 62.2 (59.1-66.6); snout length 44.6 (42.8-46.5); eye diameter 25.6 (21.1-27.5); interorbital space 31.7 (28.5-36.2); dorsal fin base length 71.7 (67.6-75.9); pectoral fin length 84.6 (80.2-92.2) and anal fin length 34.6 (32.7-36.6) of HL. Caudal peduncle depth 116.6 (112.1-125.6) % of its length.

Sexual dimorphism: Not known.

Colour: Body light brown with 14-18 black bars extending from back up to about ¾ of body. Bars wider than interspaces, most of them in paired form. Predorsal bars are many, as wide as interspaces, thinner and less well marked than those behind the dorsal fin; not interconnected with their counterparts dorsally in small specimens. A dark spot at the base of the last simple rays to second branched dorsal fin rays. Bar at caudal base interrupted and represented by two spots. 3 transverse bands on the head, one each on internarial, interorbital and on the occiput area. A dark spot on the occiput. A longitudinal band from the nasal opening to the tip of the snout.

Distribution: INDIA: Manipur: Iyei River, Noney, Tamenglong district (Brahmaputra drainage).

Etymology: The species is named after its small size.

Discussion: The species is similar to *Schistura dubia* Kottelat (1990) from Mae Nam Yom basin, Phrae Province, Thailand in having adipose crest and incomplete lateral line.

Table 2: Comparison of morphometric characters of *Schistura minutus* sp. nov. with *S. dubia* and *S. sikmaiensis* (in % of HL)

	S. minutus (FF 3749, 3750 & MUMF 1001-1003, 1005-1006, 1008 -1011) N = 11	*S. dubia* (Kottelat 1990)	*S. sikmaiensis* (MUMF 1012-1015) N = 4
	Mean (range)±S.D.	Mean (range)±S.D.	Mean (range)±S.D.
Lateral head length	(107.0-114.1)	(108-129)	(116.0-126.3)
Head depth (at eye)	50.7(47.8-55.7)±2.65	49(43-56)±3.5	56.1(54.1-60.0)±2.61
Head depth (at nape)	62.2(59.1-66.6)±2.32	59(54-66)±3.1	67.3(64.7-69.7)±2.09
Body depth	80.1(73.8-112.8)±11.02	78(71-94)±6.4	95.4(90.7-97.3)±3.16
Snout length	44.6(42.8-46.5)±1.29	45(40-52)±2.8	42.6(40.7-44.7)±1.98
Head width (at nares)	51.7(47.4-55.1)±3.04	50(41-77)±8.5	53.6(50.5-56.5)±2.78
Maximum head width	69.4(64.7-71.7)±2.12	72(55-87)±6.9	77.7(75.0-82.2)±3.15
Gape width	29.4(27.2-32.9)±2.00	-	32.3(28.9-34.2)±2.47
Internarial space	24.2(21.5-28.1)±2.05	-	24.0(22.3-26.3)±1.64
Eye diameter	25.6(21.1-27.5)±1.9	22(16-27)±2.3	20.8(19.7-21.3)±0.73
Interorbital space	31.7(28.5-36.2)±1.93	33(30-39)±1.9	35.8(34.1-38.1)±1.70
Height dorsal fin	70.8(67.0-75.3)±2.42	67(58-85)±7.6	72.8(70.5-76.3)±2.74
Dorsal fin base length	71.7(67.6-75.9)±2.92	-	79.5(122.3-128.9)±2.99
Length of anal fin	34.6(32.7-36.6)±1.36	-	41.4(38.8-44.7)±2.59
Length of pectoral	84.6(80.2-92.2)±4.13	86(71-108)±7.7	103.5(96.0-109.2)±5.52

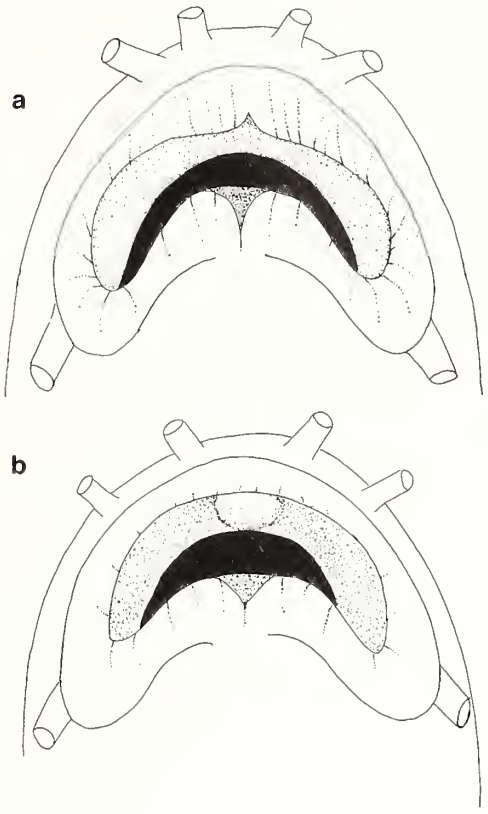

Fig. 3: Mouth of *Schistura* sp. showing absence and weakly developed processus dentiformes
a. *Schistura sikmaiensis*, b. *S. minutus*

The new species, however, can easily be distinguished from *S. dubia* in having deeper caudal peduncle (deeper than long vs. longer than depth); more bars on body (14-18 vs. 8-11); less branched pectoral rays (8-9 vs. 10-11); less branched ventral rays (6 vs. 8); in not having notch on the lower jaw and shorter predorsal length 51.2 (49.4-55.0) vs. 55.3 (53.6-56.4).

Schistura minutus also differs from *S. sikmaiensis* (Fig. 2) in presence of weakly developed processus dentiformes (Fig. 3b) vs. absent (Fig. 3a); caudal fin emarginated vs. forked; lateral line incomplete vs. complete with 100-110 pierced scales; upper lip without incision (Fig. 3b) vs. median incision (Fig. 3a) and numerous furrows.

Vishwanath and Nebeshwar (2004) gave new species status *S. reticulata* to Menon's (1987) *Noemacheilus yiuciguerrae* from Chindwin basin, Manipur, India. Vishwanath and Shanta's (2004a) *S. macrocephalus* is a junior homonym of *S. macrocephalus* (Kottelat 2000). To remove the homonymy, Vishwanath and Shanta (2004b) have proposed *S. khugae* as the new name.

ACKNOWLEDGEMENTS

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REVIEWS

1. PERSPECTIVES ON BIOSYSTEMATICS AND BIODIVERSITY: PROF. T.C. NARENDRAN COMMEMORATIVE VOLUME. Edited by K. Rajmohana, K. Sudheer, P. Girish Kumar, and S. Santhosh. Systematic Entomology Research Scholars Association, Department of Zoology, University of Calicut, Kerala, 2004. xxii + 666 pp. (14.5 x 22 cm). Contributory price US $100. Hardback.

The theme of the book is Insect Biosystematics and Biodiversity, a subject that has often been neglected in India. This led to a great paucity of good taxonomic workers, but in recent years there has been a resurgence in this field of study, as its vital importance is recognised and taxonomists are a "wanted" species again.

This commemorative volume was brought out to honour Prof. T.C. Narendran, whose contributions to insect taxonomy in research and teaching are exemplary. After passing his M.Sc. in 1967 from the School of Entomology, St John's College Agra, under the tutelage of Prof. M.S. Mani, an internationally recognised expert in the field, he initiated research on the reproductive biochemistry of insects, but being like most graduates of that School, a field biologist, he turned to the study of parasitic Hymenoptera. His association with Z. Boucek was to prove fruitful in many ways. According to P.T. Cherian in his Preface to the volume, the new species described by Prof. Narendran constitutes 0.8% of the more than 60,000 species of Indian insects presently known.

The book is in two parts, Part One focuses on insect biodiversity, with nine interesting essays on varied topics including intraspecific diversity (T.N. Ananthakrishnan), documentation of forest insect diversity (George Mathew), and monsoon butterfly species of Kudremukh National Park (T.V. Mohandas). The second part has 39 articles on biosystematics, mainly of Hymenoptera, with special emphasis on parasitic species related to integrated pest management. The list of contributors includes prominent names, including such luminaries as T.N. Ananthakrishnan, Z. Boucek, and Madhav Gadgil.

There are some photographs of personal interest, and a list of publications by Prof. Narendran at the end of the book. This compendium of scientific papers would be a valuable addition to any entomology library.

■ GAYATRI UGRA

2. HANDBOOK ON INDIAN WETLANDS BIRDS AND THEIR CONSERVATION, by Arun Kumar, J.P. Sati, P.C. Tak and J.R.B. Alfred. Zoological Survey of India, Kolkata, 2005. Pp. 469 (16 x 23 cm). Price Rs. 1,500/-.

The mandate of the Zoological Survey of India (ZSI) is to document the animal diversity of the country. The ZSI has been doing this since its establishment more than 100 years ago. Unfortunately, the ZSI is also famous for bringing out boring tomes, full of jargon and technical descriptions of new species, which interest only the subject experts. This is now changing, thanks to the books brought out by Dr. Arun Kumar and his team. I had reviewed their previous book WATERBIRDS OF NORTHERN INDIA and am happy to say that this book is far better than the earlier one. The HANDBOOK is packed with information about water birds and wetland habitats. I would say that anyone who is interested in wetlands and birds should purchase this book — there is something for everyone, from an expert to an amateur birdwatcher to a Protected Area Manager.

A total of 310 wetland and wetland-associated bird species are fully described with diagnostics characters — voice, habitat, habits, food, status and distribution. All the species are illustrated either by photographs or diagrams. The distribution maps are reasonably correct, based on existing records and probable distribution. The maps and charts are in colour and well drawn. The authors have extensively used symbols to show birds that are resident, vagrant, probably extinct, near threatened, possible breeding and so on. Habitat-specialist or vagrant species such as the Long-tailed Duck, Sociable Lapwing, and Slaty-legged Crake, that have isolated records, are represented by colour dots. The authors need to be commended for collecting a large number of good pictures of birds. However, some pictures are below standard (for instance, a flock of Garganey, Sand Martin, Black-breasted Parrotbill) and could have been avoided. The design and layout are also good. For comparison with similar-looking waders, illustrations are given which would certainly help in identification. However, as the book weighs 1.54 kg, it is not easy to carry it in the field. It is basically a reference guide for wetland birds. Besides the main text, the following

chapters are very useful and full of information: Status of Wetland Birds, Protected Area Network, and Framework for Conservation. The authors have compiled information from various sources such as the Wetlands International, BirdLife International, Bombay Natural History Society, Ramsar Bureau, and Asian Waterfowl Count. All in all, I find the book very useful and recommend it to all University and Conservation Institute libraries. At a steep cost of Rs. 1,500/- it will deter many bird watchers, but it is worth the investment.

■ ASAD R. RAHMANI

3. FOCUS ON SACRED GROVES & ETHNOBOTANY, Edited by Dr. Vinaya Ghate, Dr. Hema Sane, Dr. S.S. Ranade. Prism Publications, Mumbai, 2004. Pp. 253 (18 x 24.5 cm). Price Rs. 650/-, US $ 45. Hardback.

This book was released amidst sylvan surroundings, in one of the sacred groves of Nandivli, in the hills near lake Mulshi, Pune District. Over 100 nature enthusiasts, botanists, zoologists, foresters, environmentalists, and local panchayat staff were witness to the book release by Mohan Dharia. I felt that Prof. Dr. Vartak's legacy — his love for nature and conservation — was honoured.

The book is a compendium of four books, comprising of some of Prof. Dr. Vartak's published papers on Sacred Groves and Ethnobotany in Part I and papers presented at the National Seminar on 'Ethnobotany and Sacred Groves: Role in Conservation Strategy for India' in Part II.

The book is well designed with illustrations in black and white and special centre pages in colour. The 'Overview on Vartak's Work' is a crisp tour through the contents of the book. It also details the contemporary academic atmosphere that shaped Prof. Dr. Vartak's career. These insights are written with intimacy and knowledge of the pioneer and the subject.

Ethnobotany is a new term for the old practice of studying the usefulness of plants and animals. The prefix 'Ethno' began to be added in late 19th century to refer to ways in which 'local people view the natural world'. Late in the 20th century, as this field gained importance, there was an expansion of the term Ethnobotany beyond the original confines of Western countries. With this background the present book is a welcome addition as an introduction to the work of a pioneer. It provides a glimpse of the popularity of Ethnobotany as a subject with an emphasis on studies conducted in the Western Ghats.

The Foreword is written by the eminent scientist Prof. M.S. Swaminathan. As regards the contents, Part I includes 12 published papers on Sacred Groves, which are much quoted and referred to by Dr. Gadgil and Prof. Dr. Vartak. They brought the Sacred Groves to public attention. The papers on Inventorization of Sacred Groves of Tribals are notable papers. Prof. Dr. Vartak's activity as a field worker in diverse areas of Western Ghats has led to a paper on *in situ* conservation for which he was commended. Papers on Sacred Groves by Seminar participants are covered in Part II. Of the six papers one is on Unnoticed Sacred Groves by Reddy and Anjaria which expands the horizon of the study to Gujarat. Papers on the Digitization of sacred Groves and the Role of CITES present new trends in these studies.

Plants and their significance in the past is covered in a paper by Dr. Sane and Dr. Ghate. I would like to add that the current tally of Sacred Groves in Maharashtra is about 4000, marking a four-fold rise in the number of Sacred Groves as studied by Prof. Dr. Vartak. These new developments are noted in the Abstract.

The book provides an account of the first studies in this subject as well as the latest developments. One can trace the history of exploration of Sacred Groves. It is pertinent to note that when today huge grants are available for exploring Sacred Groves for a large group, Dr. Vartak's group of only 2 individuals (Dr. Madhav Gadgil) accomplished this tremendous pioneering work. He has explored and documented all this on personal initative and resources.

The second section of Part I deals with papers by Prof. Dr. Vartak based on his interest in Ethnobotany after he gained experience and insight in floristic aspects. The papers on Wild Edible plants from Hill Region and Enumeration of medicinal plants from Karnala hill area are a detailed study of food plants and medicinal plants used by tribals. There is a focus on *Caryota urens*, *Meyna laxiflora* as important plants offering subsistence to tribals.

It is evident from the seven papers that make up the second section of Part II that a new generation of scientists is getting involved in this field. The socio-economic impact is seen in the paper on plants of Aravali. A cultural study is presented in the paper on Korkus of Melghat. Ethno medicinal plants from Chattisgarh region, plants of south-western Maharashtra provide cures for skin diseases. Bioprospecting of *Pteridium* strikes a new note and a paper on correct identity of barks by Ms. Mahekar and Dr. Yadav provides examples of future directions of this Science in India.

The book is a welcome addition to the field and will serve as excellent source material for Prof. Dr. Vartak's rare papers and will stimulate an interest in this topic among the general readers.

The illustrative and thematic presentation of coloured photos of Sacred Groves, Archaeological repository, Museum of Giant tree lianas, treasure trove of rare places, tribals, and their food resources form interesting centerspreads.

Currently, the term Biodiversity is linked with sustainable development and preservation of Ecosystems, the presence of Sacred Groves and their preservation over a period of thousands of years is a phenomenon unique to India. This book makes us realise its importance to inspire us to make efforts for their preservation.

■ S.S. RANADE

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MISCELLANEOUS NOTES

1. OCCURRENCE OF THE TIBETAN SAND FOX *VULPES FERRILATA* HODGSON IN LADAKH: A NEW RECORD FOR THE INDIAN SUBCONTINENT

Owing to its location at the tri-junction of Central Asia, Southeast Asia and Africa, India harbours a diverse assemblage of flora and fauna (Mani 1974), and it is on the list of twelve 'megadiversity' nations in the world. Covering about 2% of the world's land surface, India houses about 9% of all the mammalian species and more are being added to this rich biological repertoire with some even new to science (Datta *et al.* 2003; Mishra *et al.* 2005; Kumar *et al.* 2005; Sinha *et al.* 2005; Mishra *et al.* in press). Presently the country is thought to harbour 419 species of mammals of which 61 are carnivores including 7 canids (Johnsingh and Manjrekar, in press).

In this note, we describe the occurrence of the Tibetan Sand Fox *Vulpes ferrilata* in Ladakh, Jammu and Kashmir, India. The species is widely distributed on the Tibetan Plateau, but hitherto it has not been reported from India. However, given the location of Ladakh at the western edge of the Tibetan Plateau, some authors have speculated that the species could occur in this region (Postanovicz 1997, Schaller and Ginsberg 2004). Schaller and Ginsberg (2004) note that no reliable evidence exists of its occurrence outside certain Chinese reserves such as the Arjin Shan, Xianza, Chang Tang and Hoh Xil. Early works on Ladakh's mammalian species, (Ganhar 1979) as well as more recent inventories (Pfister 2004) have not enlisted this species. Johnsingh and Manjrekar (in press) also have not mentioned about the occurrence of the species within the Indian Territory, and have described it as one of the lesser-known mammals of South Asia. All these indicate that the species has not been documented from India and our finding adds one more species to the list of carnivores of Ladakh as well as the Indian subcontinent.

The Tibetan Sand Fox is a small carnivore (3.0-4.5 kg) of the Family Canidae. The dorsal part and the flanks are sandy to pale rufous, and the neck, thighs and rump are greyish. The underparts are also whitish to light grey, and the tail is bushy with a white tip (Schaller and Ginsberg 2004). The Tibetan Sand Fox is morphologically distinct from the Red Fox *V. vulpes*, whose distribution overlaps with that of the former over large tracts of the Tibetan Plateau. The Red Fox is larger (4.6-5.3 kg), and conspicuously rufous with dark grey to black legs and tail. The two species also somewhat differ in their habitat use, as the Tibetan Sand Fox inhabits alpine meadows with rolling terrain within an altitudinal range of 2,500-5,200 m, whereas the Red Fox occupies relatively rugged terrain, and is often found in wooded areas as well (Schaller 1998, Schaller and Ginsberg, 2004). The Tibetan Sand Fox is morphologically more similar to the Corsac *V. corsac*, but the two have non-overlapping distributions (Schaller and Ginsberg 2004).

The geographical range of the Tibetan Sand Fox extends over the Tibetan Plateau encompassing Xinjiang, Gansu, Qinghai and Sichuan provinces (China) and Mustang (Nepal). In a survey of 43 counties of Tibet Autonomous Region (TAR), *c.* 37,000 Tibetan Sand Foxes were estimated by Piao (1989). The Red Fox on the other hand has a very wide distribution encompassing the entire northern hemisphere except Iceland and some arctic islands (Macdonald and Reynolds 2004). The Corsac is also widely distributed in central Asian countries of Turkmenistan, Uzbekistan, Tajikistan and Kazakhstan, extending eastward into Russia and westwards into parts of Europe.

We surveyed the Parma Valley and the Pangong Tso Basin in August 2000, Hanle and the Chumur valleys of eastern Ladakh during July-August 2004, and Hanle and Kuyul valleys in March-April 2005. The latter two surveys were carried out in conjunction with an ecological study on the Tibetan Gazelle *Procapra picticaudata*. The surveyed areas are part of the vast plains of the Tibetan Plateau that extend westwards into the Ladakh region of the Indian Trans-Himalaya. Topography is characterised by open and rolling terrain interspersed with rocky terrain, and altitude ranges from 4,000-5,500 m. Owing to the rain-shadow effect of the Greater Himalaya, precipitation is minimal (100-400 mm annually), occurring mostly as snow. Temperatures range between –35°C in winters and +20°C in summers. The large mammals of the area include the Tibetan Gazelle, Tibetan Wild Ass or Kiang *Equus kiang*, Tibetan Argali *Ovis ammon hodgsoni*, Blue Sheep or Bharal *Pseudois nayaur*, and their predators such as the Snow Leopard *Uncia uncia*, Tibetan Wolf *Canis lupus*, Eurasian Lynx *Lynx lynx* and the Red Fox *Vulpes vulpes*. Small mammals include Pikas *Ochotona* spp. and Voles *Alticola* spp., which are important prey for the Tibetan Sand Fox (Mitchell 1977, Schaller 1998). People are predominantly nomadic pastoralists, although some cultivate on a limited scale.

During various surveys, the plains and the rolling mountain slopes were scanned with binoculars and spotting scopes to record wildlife. Apart from field surveys, we also enquired the local people about the occurrence of fox in their area. On an affirmative response, they were shown the pictures of the Red Fox (picture of the Tibetan Sand Fox was not available) and asked whether the animal they had seen

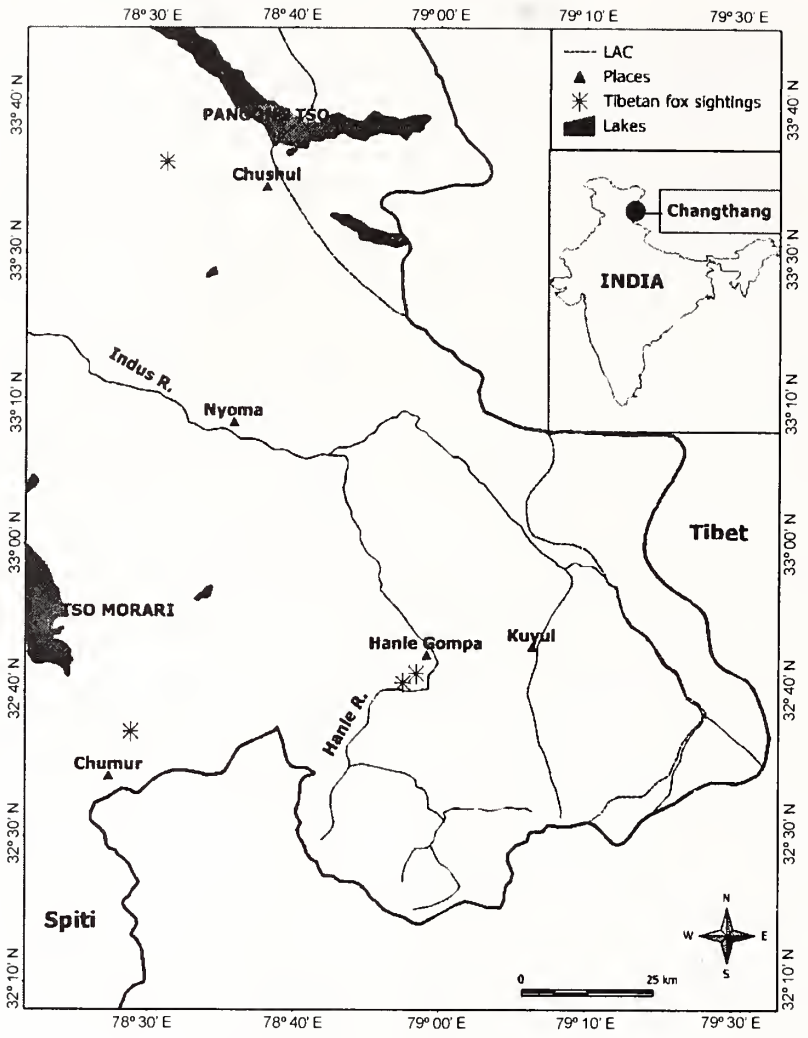

Fig. 1: Locations of the Tibetan Sand Fox sightings in Changthang, Ladakh, India

could differ from the Red Fox. The villagers were also asked if they possessed the fur of any of the two foxes as it is traditionally used for making hats, and lining traditional Ladakhi dresses.

The Tibetan Sand Fox was sighted on four occasions during these surveys. The first observation was made on the Kajukongka La (pass) between the Parma Valley and Chushul (Bhatnagar and Wangchuk 2001, Fig. 1). During a 10 minute observation through binoculars, we noted that the animal was distinctly pale rufous coloured, and had a large bushy tail with a white tip. The second sighting was in the Chumur Valley on July 15, 2004. While driving in the evening, we saw a fox scurrying across a slope above the road. On a closer look through binoculars, it turned out to be the Tibetan Sand Fox. It was smaller than the Red Fox and the colour was greyish yellow with paler underparts. It stood and stared at our vehicle for about three minutes and then climbed up the slope. Interviews with the herders revealed that a fox, paler and smaller than the Red Fox, does occur in the region. Further, they revealed that this fox is known to them by the local name *Sili*, whereas the Red Fox is called *Aatse*.

We continued our survey in Hanle in 2005, and sighted the Tibetan Sand Fox on two more occasions. On April 3, 2005 at 0930 hrs, we came across a fox on the southern slope of the Sdikpa Raza Hill near Hanle Gompa (Monastery; Fig. 1). It was moving across a gravel-strewn slope above the link road to the Pungug Village, sniffing and squatting intermittently on low shrubs of *Artemisia* and *Eurotia* spp. Villagers had also reportedly seen *Sili* on the same hill. Next morning we visited the same site, and saw two individuals. One fox emerged from behind a large boulder and rushed towards a smaller boulder where another fox was lying down. After nuzzling the resting fox, it moved up the slope. We visited the site again in the evening to check for any dens, but in vain. We, however, found the resting sites and scats entangled in low shrubs. In one of the scats, there were many *Ephedra* seeds.

However, we did not observe any Tibetan Sand Fox in the Kuyul Valley. Interviews with the local pastoralists, known as *Changpas*, revealed that the species was common in the valley some 20 years ago, but has since declined. The *Changpas* claimed that the species is not persecuted currently due to the implementation of conservation laws. We, however, came across many hats made of Red Fox skin acquired in the past, but none from the skin of the Tibetan Sand Fox. We were told by the locals that when hunting was widespread, Tibetan Sand Fox was persecuted less compared to the Red Fox, as its fur was considered inferior.

The natural history of the large mammals of the Ladakh Region was documented by explorer/travellers of the early 20th century (Burrard 1925; Stockley 1936). More recently, the large herbivores and carnivores of the region have been well documented by naturalists and field biologists (Ganhar 1979; Mallon 1991; Fox *et al.* 1991; Pfister 2004). Nevertheless, the occurrence of the Tibetan Sand Fox remained undocumented, perhaps because large tracts of the remote eastern Ladakh (potential habitat for the species) were out of bounds for many surveyors. It is also possible that those who visited the area and saw the animal mistook it for the Red Fox, which is widely distributed in Ladakh (Mallon 1991).

Our finding indicates that the fauna of Ladakh, especially smaller animals of the lesser-known genera remain largely unknown. In any case, although our surveys have established the occurrence of the Tibetan Sand Fox in Ladakh, its status and distribution in the region remain to be documented. According to the *Changpa* pastoralists, *Silis* were relatively common in Changthang in the past, but the encounter rate has declined in recent years. Moreover, unlike in the case of Red Fox, which is well studied (Macdonald and Reynolds 2004), there is no information available on the reproductive and social behaviour of the Tibetan Sand Fox throughout its range (Schaller and Ginsberg 2004). Therefore, there is an urgent need to gather baseline information on its status, distribution and ecological aspects, which are crucial for developing appropriate conservation strategies. We have plans for further surveys in the coming years in Ladakh to assess the distribution and threats to the species.

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2. DOMESTIC DOG (*CANIS FAMILIARIS*): THREAT FOR THE GOLDEN LANGUR *TRACHYPITHECUS GEEI*

Primates are sensitive to the risk of predation (Dunbar 1988), and both actual predation and the risk of predation influence the behavioural strategies of the species. Primates often fall prey to predators, especially carnivorous mammals and birds.

The Dog (*Canis familiaris*) is one of the earliest domesticated animals. It is the most common domestic animal in the villages adjoining the forests in Assam. This poses a threat to the wildlife.

The Golden Langur (*Trachypithecus geei*) is a restricted range species, its distribution in India being confined to a forest belt between river Manas in the east, Sankosh in the west and, Brahmaputra in the south in the Indo-Bhutan Border. Many populations of Golden Langur now live in forests adjoining human settlements. They are compelled to move on the ground due to the canopy gaps, where they are vulnerable to attack by dogs.

A socio-ecological study of the Golden Langur was carried out in Chakrashila Wildlife Sanctuary in Dhubri district of Assam during 2001-2002. In this study, several aggressive encounters between the domestic dog and the Golden Langur were observed. The death of an adult male and an adult female of the same troop, due to predation by domestic dog, occurred in Jornagara, a village on the fringe of the Chakrashila Wildlife Sanctuary, on January 6 and on February 12, 2002. The villagers reported a few killings of Golden Langur by domestic dogs in the same area. Observations of aggressive encounters between a semi-provisioned group of Golden Langurs and domestic dogs in Umananda River Island in Guwahati during a long-term study also support this view (Medhi 2002).

The villagers use dogs to chase away the monkeys to prevent crop raiding. A survey in the fringe villages of Chakrashila Wildlife Sanctuary revealed that every year 3-4 Rhesus Macaques (*Macaca mulatta*) also fall prey to dogs.

These incidences show the emergence of both domestic and stray dogs as a threat to primates in general, and the Golden Langur in particular.

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3. AN UPDATE ON THE ELEPHANTS OF INTERVIEW ISLAND

Introduction

Elephants were brought over to the Andaman Islands for forestry operations. One such forestry operation was carried out on Interview Island, west of Mayabunder on Middle Andaman Island. Since the company carrying out the operation went bankrupt, the elephants being used were released on the island in 1962. Approximately 40 elephants were released then (Sivaganesan 1993).

Elephants are not normally found in the Andamans. Interview Island is predominantly evergreen and semi-evergreen forest and has an area of 133.87 sq. km (Fig. 1)

Fig.1: Map of Northern part of Andaman Islands showing Interview Island

according to the Forest Department (Anon 1998). However, this calculation is based on the low tide line; the area under vegetation is around 105 sq. km. A percentage of this is under mangrove, which is not used by elephants. Sivaganesan and Kumar (1995) estimated the available habitat for elephants to be around 70 sq. km.

In 1992, Sivaganesan and Kumar (1995) conducted a census of these elephants using dung counts. The numbers estimated were around 70 animals. This indicates a phenomenal growth in population. Considerable damage to the vegetation was recorded during this study, raising concerns about the future of this population. I therefore carried out another survey in 2001.

Local information gathered in December 2000 indicated that elephants were found in herds of 5-10 individuals (Andrews, pers. comm.). It was established that their movements over the island was highly seasonal, with certain areas being preferred at certain times of the year. Their movements were also constrained by the proximity of water since there were limited perennial waterholes on the island. Nine major waterholes were identified on Interview Island, and the herds moved from waterhole to waterhole. *Machans* were therefore built in January near six of these waterholes.

The survey began on February 16 and continued until the end of March. There were 35 census days in this period. Only the days when new individuals were sighted have been shown in the tables. Because of the heavy rains preceding this period, it was found that observations from *machans* were not yielding much information (since water was available at many sites). Experienced trackers were then employed to quarter the forests, locate individual herds and follow them while trying to identify as many individuals as possible. It was expected that the rate of detection of new animals would level off as more and more were found: this did in fact happen. No new elephants were seen after the 17th day.

A check sheet with the frontal and lateral views of elephant was developed, where identifying features such as pale patches and scars were marked. The trackers were interviewed in-depth each day, and an understanding of elephant movement on the island during that period was gained.

Grid locations were not used, since at that time there was no accurate method of estimating precise locations on

Table 1: Sighting of elephant groups on Interview Island during the study period

		Herd						Unattached adult Males			
Date	Location	AM	AF	SF	JM	JF	J?	Calves	Single	Groups	Total
17 February	Papita Dera	2	5	3	1	1	2	2	0	0	16
19 February	3 km West of FRH		2					1	0	0	3
22 February	1 km West of FRH		1	1			1		0	0	3
24 February	Tochi nullah	1	1	2			1		0	0	5
03 March	Asay Saka	2	1				1		0	0	4
Total		5	10	6	1	1	5	3	0	0	31

AM = Adult male, AF = Adult Female, SF = Subadult Female, JM = Juvenile Male, JF = Juvenile Female, J? = Juvenile unsexed

the island. However, names given by the local residents were used. The age categories used were calf (0.9-1.2 m), juvenile (1.2-1.8 m), sub adult (1.8-2.4 m) and adult (more than 2.4 m). Since there were few animals and they were in herds, ambiguity was minimized.

Table 1 shows elephant sightings over time. A total of 31 elephants were counted. No new sightings were made after the 17th day, and it is expected that the number will not exceed 35. The small number made individual identification possible, hence capture-recapture analysis techniques using a few identifiable individuals were not required.

Of the ones counted there were 5 adult males, and 10 adult females. The rest were either sub adults or juveniles. This contrasts with Sivaganesan's (1993) finding that there were about 70 elephants. Figure 2 plots number of elephants sighted against number of days of observation, and it can be seen that the number of elephants plateaus out between 30 and 35.

The differences found between this study and Sivaganesan's needs to be explained. The earlier study used dung transects combined with defecation and decay rates, and a census for dung of only those areas that had concentrations of elephant was conducted. This could have biased the counts towards areas that had more elephants, leading to the higher density count.

Since the elephants were found to be highly seasonal, a short study would not eliminate bias due to seasonal movement. Also, estimates based on dung introduce variations due to individual animals and changes in diet. Their use would best suit long-term studies, preferably after population numbers are validated using some other method.

A second possibility is that both the methods have yielded accurate estimates and there has been a population decline. One possibility is that there has been poaching; another is that the habitat has degraded and cannot support the elephant population. In fact, there is some support for

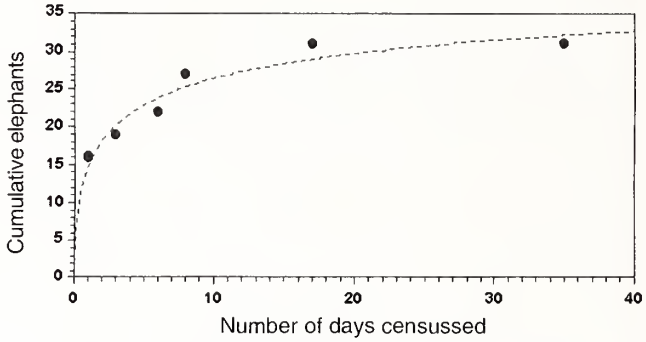

Fig. 2: Number of elephants seen with days censussed

this point of view. The third possibility that elephants have dispersed to other islands can be ruled out since there are no new sightings on the neighbouring islands.

Of the total adult males seen, 3 were tuskers and 2 were *makhnas*. The single juvenile male seen was a tusker. Sample sizes are too small to perform meaningful analysis to see if there is any difference. The lack of sightings of sub adult males is probably an artefact of the small sample size.

The vegetation damage described by Sivaganesan has now become worse. This is discussed in detail elsewhere (Ali *et al.* in prep.) There was practically no bamboo, cane or *Pandanus* seen anywhere on the island, and these were not sampled in the transects. Several species of trees found debarked during this study were not recorded as eaten earlier. An analysis of the vegetation, which will be presented separately, indicates that as trees die they are unlikely to regenerate due to browsing by Chital (*Axis axis*) – another introduced species.

The condition of many of these elephants seems emaciated. These elephants are invasives and as they are outstripping the food supply of the Island, the logical management recommendation is their removal from the island. Culling is one such option; translocation to the mainland after trapping is another.

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4. STATUS AND DISTRIBUTION OF GREY GORAL (*NAEMORHEDUS GORAL*) AND SEROW (*CAPRICORNIS SUMATRAENSIS*) IN KUMAON HIMALAYAS, UTTARANCHAL, INDIA

Introduction

Of the three species of goat antelopes in India, the Grey Goral (*Naemorhedus goral*) and the Serow (*Capricornis sumatraensis*) – are found in Kumaon Himalayas (Prater 1997). The Grey Goral is widely distributed from low to medium altitude, while the Serow is restricted to higher altitude zones. The Kumaon Himalayas comprising Almora, Pithorgarh and Nainital districts in Uttar Pradesh, India, cover an area of about 21,000 sq. km, (28° 43' 55"-30° 30' 12" N and 78° 44' 30"-80° 45" E) (Fig. 1). They were once covered with extensive tracts of oak forest (*Quercus* spp.), but clearance of forest and changes in land use pattern by man during the last two centuries have led to the fragmentation of the oak forest. Large areas have been replaced either with Chir Pine (*Pinus roxburghii*) or terrace cultivation.

The large-scale changes in the Kumaon Himalayas have impacted the animal community, especially the goat antelopes. The populations of goat antelopes have been confined to small oak patches and no information is available on the present status and distribution of the two species in Kumaon Himalayas. Considering this we conducted extensive surveys throughout the Kumaon Himalayas to document the present status of the Grey Goral and the Serow in extant oak patches.

Study area

The Kumaon Himalayas present a variety of habitat types ranging from moist deciduous forests at lower altitudes in the Siwalik hills to alpine meadows at higher reaches of the Himalayan mountains. Extensive tracts of

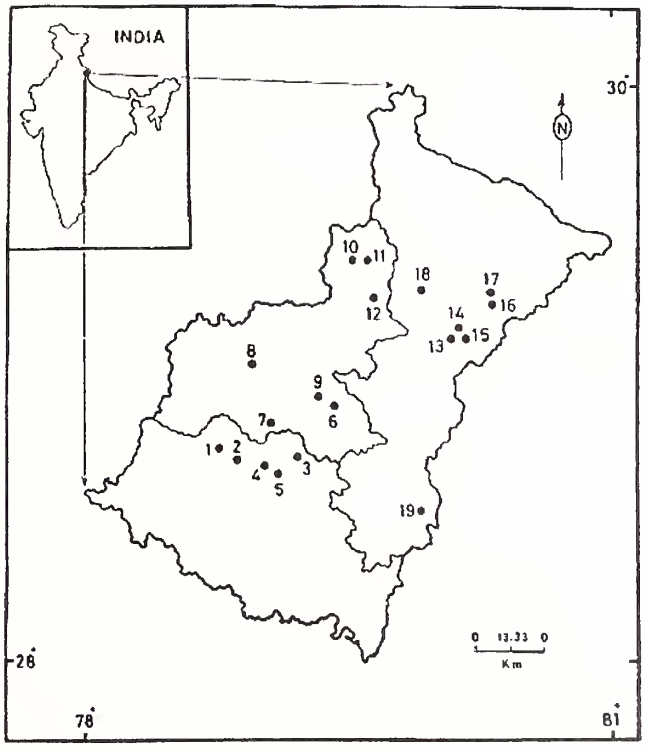

Fig. 1: Map showing location of the surveyed sites

Shorea robusta (Sal) forest dominate the Siwalik hills and extend up to an altitude of 1200 m (Saxena *et al.* 1985). Beyond this, pine forests dominate the landscape up to 2400 m. Oak forests occur at middle altitude of Himalayan hills, between 1300 m and 3200 m. The temperate broad leaf forest that includes species such as *Taxus baccata*, *Tsuga dumosa* and *Betula utilis* occur between 3200 m and 3500 m, above this altitude lies the alpine zone dominated by shrubs and grasses.

Methodology

Nineteen sites were selected in Kumaon for investigating the current status of goat antelopes (Fig. 1). Surveys were conducted during pre- and post-monsoon in 1997. The data collected on the status and distribution of ungulate species included direct sightings and indirect evidences such as pellet groups along the existing forest trails. The length of forest trails varied from 1-1.5 km. During the surveys, at each site, existing forest trails were monitored on a daily basis in morning hours to gather data on the status of different ungulate species. Since direct sightings of animals were few, data on pellet groups along the forest trails were also collected. Pellet groups of each species were counted in 10 m radius circular plot established at 100 m intervals. These plots were established at 10 m on either side of the trails to avoid sampling of relatively disturbed vegetation along the trails. A total of 634 such plots were sampled in 19 sites. Pellet groups of the two species (Grey Goral and Serow) were distinguished on the basis of shape, size and colour, which differed markedly between the species.

The sightings of different ungulate species were used to calculate encounter rates in terms of 100 hours of observations. The number of pellet groups for each species in each plot was used to calculate pellet group density (pellet groups/ha ±SE) for each species using the formula:

$$\text{Pellet group density/ha} = \frac{\text{No of pellet groups}}{\text{Plot area}} \times 10{,}000$$

Grey Goral: The direct sighting of the Grey Goral was recorded from 5 surveyed sites and indirect evidences from 13 sites (Table 1). Grey Goral encounter rate was highest in Kunjakharak (54.5 groups/100 hours) followed by Binsar (17.81), Binayak (9.5), Maheshkhan (7.8) and Gandhura (5.08). Pellet group density of goral was highest at Kunjakharak (68.4 ±19.0) and lowest at Gandhura (1.03 ±1.0). The overall pellet group density was 8.8 ±0.64. Grey Goral prefer open cliffs and steep grassy slopes, they predominantly graze, and sometimes feed on herbs and acorns of Oak (*Quercus* sp.) (Orus 2001).

Serow: We did not have direct sighting of the Serow, but pellet groups were recorded from three sites: Sunderdhunga, Pindari and Munsiyari. It lives solitarily or in pairs and is generally encountered in birch forest above the pine zone. It prefers high altitude with low tree cover, but good shrub ground cover. Pellet group density was highest (12.0 ±6.3) at Sunderdhunga and lowest (2.38 ±1.7) at Pindari. Overall pellet group density was 0.88 ±0.64. Serow is regularly poached for meat.

The Serow occurs at higher altitude areas (> 1850 m) and therefore has restricted distribution in Pindari, Sunderdhunga and Munsiyari. The Grey Goral, whose distribution covers low and middle altitude areas, has disappeared from certain patches. In general, however, there were very few direct sightings of both the species, which suggests very low density of these species. While changes in land use pattern have drastically reduced the distribution of goat antelopes species, the extremely low density in the forest patches has been due to high poaching pressure. During the surveys, poaching was found to be common

Table 1: Direct sightings and pellet group density (pellet groups/ha ±SE) of Grey Goral and Serow recorded at different sites surveyed in Kumaon Himalaya

Site name	Site code	Altitude range	Goral	Serow
Kunjakharak	1	1900-2400	68.4±19.0*	00.0±0
Binayak	2	1900-2500	8.49±3.0*	00.0±0
Mukteshwar	3	1500-2300	00.0±0	00.0±0
Gager	4	1700-2300	2.12±1.4	00.0±0
Maheshkhan	5	1900-2300	00.0±0*	00.0±0
Jageshwar	6	1900-2100	00.0±0	00.0±0
Sitlakhet	7	1900-2100	00.0±0	00.0±0
Pandavkholi	8	1800-2500	16.7±5.0	00.0±0
Binsar	9	1500-2400	19.6±10.7*	00.0±0
Sunderdhunga	10	2500-3500	1.82±1.2	12.0±6.3
Pindari	11	2300-3500	2.38±1.7	2.38±1.7
Gasi	12	2300-2900	5.57±3.5	00.0±0
Gandhura	13	1500-2600	1.03±1.0*	00.0±0
Daphiyadhura	14	1300-2440	14.0±3.8	00.0±0
Majtham	15	1300-2700	9.55±4.0	00.0±0
Duku	16	2100-3500	0.0±0	00.0±0
Sobla	17	1900-3500	16.7±5.2	00.0±0
Munsiyari	18	2100-2200	00.0±0	2.55±2.5
Mechh	19	2100-2200	1.59±1.5	00.0±0

Status = *= direct sightings

throughout Kumaon, including in established protected areas (Khan 1998).

Conservation problem: Due to excessive dependency of the local people on oak patches for fuel wood, fodder and timber, the forests are getting degraded and are shrinking in size. Moreover, the pine forests are encroaching the oak forests, which is not a good sign for the Grey Goral and the Serow habitat.

The other major threat is poaching of wildlife, which is widespread throughout Kumaon. Poaching is highest in the Sunderdhunga, Pindari and Munsiyari areas where locals hunt the Grey Goral and the Serow for meat. In Pithorgarh district, hunting pressure is very high towards the Askot Wildlife Sanctuary, as international boundaries with Nepal and Tibet meet in this area. This is also an old trade route. These routes are still being utilised for poaching animals such as Musk Deer *Moschus chrysogaster* (Hodgson) and the Himalayan Black Bear *Ursus thibetanus* (G. Cuvier.)

Conservation strategy: In Kumaon Himalayas, there are only two wildlife sanctuaries, i.e. Binsar and Askot, which together cover about 645 sq. km. Both sanctuaries have very high anthropogenic pressures. Binsar is just 45 sq. km in size. Both sanctuaries conserve only the Grey Goral leaving the Serow unprotected. In order to conserve both species, the protected area coverage must be increased. Areas such as Kilbary, Binayak and Kunjakharak in Nainital and Pindari and Sunderdhunga region in Almora district have very high conservation potential and therefore should be declared as protected areas. There is also a need for placing some regulation on cutting and lopping of trees and grazing. A better control of poaching in the remaining unprotected oak patches is also needed.

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5. RECORD OF THE CHINESE GORAL *NAEMORHEDUS CAUDATUS* IN ARUNACHAL PRADESH[1]

Introduction

Ungulates are believed to be amongst the best documented taxa of large wildlife, with only ten new species being described between 1930 and 1994 (Pine 1994). Yet, the past decade saw a spate of ungulate discoveries in Southeast Asia, with four species new to science being described between 1994 and 1998 (Schaller and Vrba 1996; Giao *et al.* 1998; Rabinowitz *et al.* 1998; Amato *et al.* 1999). These new discoveries reflect the hitherto poor status of exploration and documentation of wildlife in the remote Southeast Asian forests. In India, the wildlife of the northeastern state Arunachal Pradesh (26° 28'- 29° 30' N and 91° 30'- 97° 30' E; 83,743 sq. km) has remained poorly documented. One of our surveys in 2002 recorded the Leaf Deer *Muntiacus putaoensis* in Arunachal (Datta *et al.* 2003), a new species that was first found in the adjoining forests of Myanmar in 1997 (Rabinowitz *et al.* 1998; Amato *et al.* 1999). This record of the Leaf Deer in the mid-elevation forests of Eastern Arunachal is so far the only new addition to the list of large mammals of the Indian subcontinent in the last century (Datta *et al.* 2003).

Arunachal Pradesh is situated in the transition zone between the Himalayan and Indo-Burmese regions (Mani 1974; Rodgers and Panwar 1988). The entire state is part of the Eastern Himalayan global biodiversity hotspot (Mittermeier *et al.* 1998; Myers *et al.* 2000) as well as among the 200 globally important eco regions (Olson and Dinerstein 1998). Most wildlife surveys in Arunachal have so far been restricted to low and mid-elevation forests (Katti *et al.* 1992; Athreya *et al.* 1997; Kumar and Singh 1999; Pawar and Birand 2001; Datta *et al.* 2003). Apart from a recent survey of

pheasants in mid-elevation and alpine areas that led to the discovery of a possibly new species of pheasant (Kumar and Singh 1999), the status and occurrence of high altitude (> 3000 m) wildlife remains largely unknown. This is so despite the fact that 23% of the State's land area is at elevations over 3000 m.

We undertook a biological expedition to the high altitude areas of Western Arunachal with the objective to make an inventory of wildlife, and identify areas for possible designation as wildlife reserves. The survey, conducted in August-September 2003, covered almost the entire high altitude areas of Tawang and West Kameng districts. Here, we report a significant finding of the survey: the occurrence of the Chinese Goral *Naemorhedus caudatus* (also called Long-tailed Goral) in western Arunachal Pradesh. Choudhury (2003) had earlier reported the Chinese Goral as a subspecies of Himalayan goral *N. goral caudatus* from eastern and north-eastern Arunachal Pradesh - the Mishmi Hills and Patkai Range, in the districts of Dibang Valley, Lohit, Changlang and Tirap'. This record of the Chinese goral from western Arunachal Pradesh makes our survey region, the high altitudes of Tawang and West Kameng districts the only known region in the world to harbour all the three extant species of goral.

Goral

Goral is a goat-like animal with sturdy legs adapted for jumping and climbing. The adult body mass varies between 20-30 kg, with a head and body length of 105-150 cm and 58-70 cm at the shoulder (Prater 1971; Roberts 1977; Zhang 1987; Zhiwotschenko 1990; Corbet and Hill 1992). Sexes are similar in size and build, and have slender, backward curving, sharp pointed horns with small closely spaced annulations. Average horn length ranges from 11-15 cm, and sometimes up to 23.5 cm (Prater 1971; Roberts 1977; Schaller 1977; Mishra *et al.* 1998). Horns of males are slightly thicker at the base and are more divergent compared to females. Goral is known to inhabit a wide altitudinal range from sea level up to 4500 m, though it is mostly restricted to relatively steep, open grassy slopes (Mishra and Johnsingh, in press).

There was considerable confusion in the taxonomy of goral until Groves and Grubb (1985) proposed the currently followed classification (Shackleton and Lovari 1997), which recognizes three extant species based on morphology. The Himalayan Goral *N. goral* occurs in the Himalayas and northeast India (spreading over India, Pakistan, Nepal, China, Bhutan and Myanmar), the Red Goral *N. baileyi* is restricted to a relatively small area of Arunachal Pradesh, Southeast China and Northern Myanmar, and the Chinese or Long-tailed Goral *N. caudatus* is found in China, Myanmar, Thailand, Laos, North and South Korea, and the Russian Federation (Shackleton 1997). Both the Himalayan and Chinese goral are known to feed predominantly on grass (Zhiwotschenko 1990; Mishra and Johnsingh 1996).

Goral in Arunachal Pradesh

The Himalayan and Red Goral are known to occur in Arunachal Pradesh. Recently, Choudhury (2003) has reported the Chinese Goral from eastern Arunachal Pradesh, though we have so far not recorded the species in our surveys in the eastern district of Changlang and Tirap (unpublished data). During the present survey we found that the Red Goral and Himalayan Goral are commonly hunted in Tawang and West Kameng. The *Monpa* herders often make coarse jackets and trousers of Himalayan Goral hide, which are apparently very effective against rain and cold. Each garment requires skins of two adult goral, which can be purchased from hunters for *c.* Rs. 300 each. Although we did not sight the Himalayan Goral during our survey (largely because we were surveying areas above 3000 m; the species is relatively more common in lower altitudes), we saw several skins with hunters, and with herders who were wearing them. One of us (CM), accompanied by two hunters, sighted two Red Goral in Phurgang (Fig. 1) in West Kameng district. The goral were seen along a cliff at an altitude of 4100 m. We observed them from below at a distance of 300 m, and since they were silhouetted against the sky, we were unable to ascertain whether they were Himalayan or Red Goral. However, the hunters accompanying us as guides were positive that they were Red Goral, having killed one in the same site a few months back. We also saw fresh signs of Takin *Budorcas taxicolor* and Musk Deer *Moschus* sp. in this area.

Two of us (CM and AD) spotted the Chinese Goral, about 3 km from Thingbu village (Fig. 1), in the Mago Chu Valley of Tawang district, while on the trail between Mago village and Thingbu. We first saw an adult male feeding in an open, steep grassy patch within Fir *Abies densa* forest at an altitude of 3000 m. The animal was dark chocolate in colour, except for the lower limbs, which were rufous. It had a small but distinct white patch on the throat. The dorsal side of the neck and shoulder had a black patch, which tapered to become the dorsal stripe, extending till the base of the tail. The tail was longer and relatively bushy compared to Himalayan Goral. After about 20 minutes, a female and a young joined the male, both of which had a relatively lighter coat colour. We watched this herd for another 15 minutes with binoculars, from a distance of *c.* 600 m, when they slowly disappeared out of sight behind some fir trees.

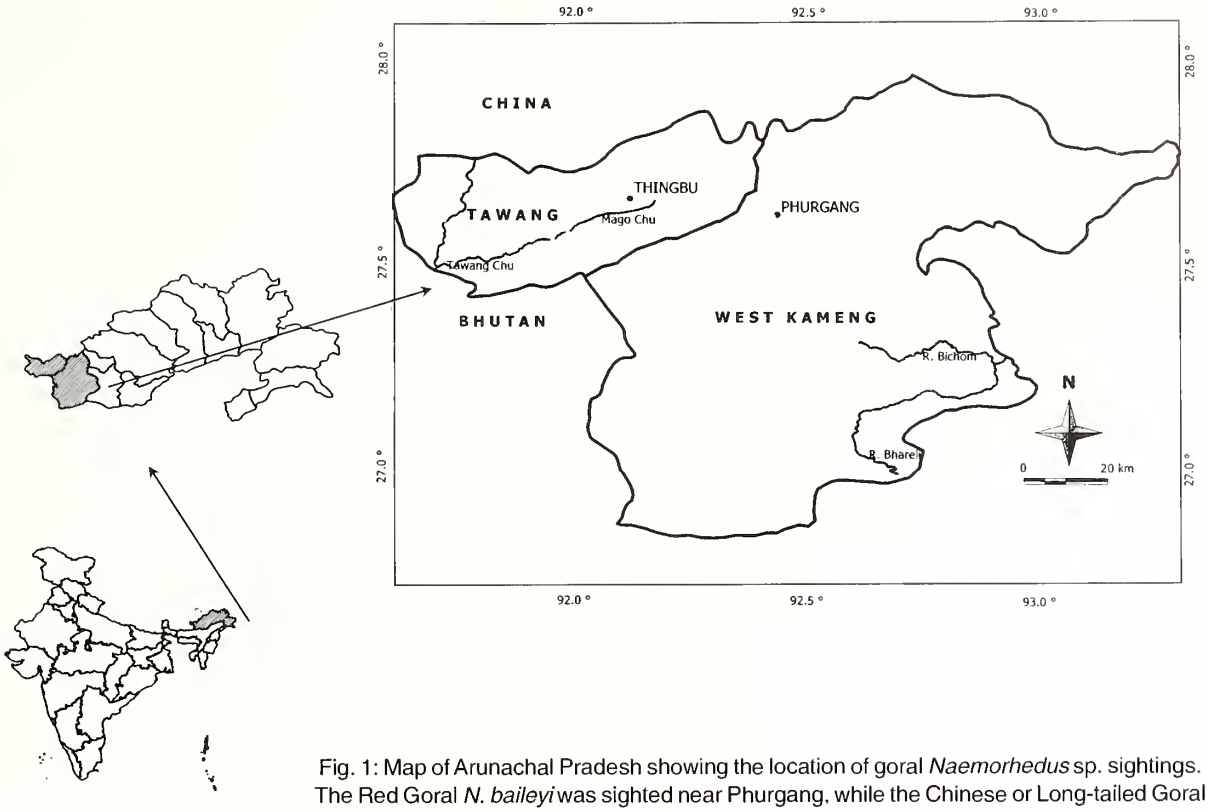

Fig. 1: Map of Arunachal Pradesh showing the location of goral *Naemorhedus* sp. sightings. The Red Goral *N. baileyi* was sighted near Phurgang, while the Chinese or Long-tailed Goral *N. caudatus* was seen near Thingbu

Conservation Status

The Red and Chinese goral are categorized as 'Vulnerable' in the IUCN's Red List of Threatened Species (IUCN 2000). The Indian Wildlife (Protection) Act, 1972 does not list the Red Goral under any of its schedules (Anon 2003), however, Schedule III of the Act lists the Himalayan Goral (*Naemorhedus goral*) and *N. hodgsoni*. The Himalayan Goral has two subspecies, *N. goral hodgsoni* denotes the eastern subspecies (Groves and Grubb 1985); *N. goral bedfordi* is the Western Himalayan subspecies. Schedule III of the Indian Wildlife Act covers only the Himalayan Goral, and the reference to *N. hodgsoni* can be deleted from it to avoid confusion. More importantly, we recommend the immediate inclusion of the Red and Chinese Goral in Schedule I of the Indian Wildlife (Protection) Act. These species are of global conservation concern, and it is only appropriate that they are accorded the highest protection status under the Indian law.

Apart from China, India is the only other country to harbour all three currently recognized species of goral. In fact, the Mago Chu Valley of Tawang, along with adjoining areas of West Kameng district, is perhaps the only known region in the world to have all the three goral species. The area also has two other goat antelopes Takin *Budorcas taxicolor* and Serow *Naemorhedus sumatraeusis*. The present study has also established the occurrence of other rare and threatened wildlife in this region, such as the Snow Leopard *Uncia uncia*, Dhole *Cuon alpinus*, Musk Deer *Moschus* sp., Bharal *Pseudois nayaur*, and the Himalayan Marmot *Marmota himalayana*. Most of these species are currently hunted in this region. Establishment of community awareness and conservation programmes and designation of a protected area that is locally appropriate (such as a conservation or community reserve) are required urgently to safeguard the future of this fascinating wildlife assemblage of Western Arunachal Pradesh.

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6. CHARAKLA SALTPANS: A HAVEN FOR BLACK-NECKED GREBE *PODICEPS NIGRICOLLIS* BREHM

During a survey of coastal birds from January 11-14, 2003, we counted 1,432 Black-necked Grebes *Podiceps nigricollis* at four sites (Table 1) in Jamnagar and Porbandar districts of Gujarat. The highest concentration of about 1,400

Table 1: Count of Black-necked Grebes during January 2003, Gujarat

Site	District	Date	Number
Charakla saltpans	Jamnagar	12.1.2003	1405
Meedha Tidal Regulator	Porbandar	12.1.2003	5
Rosy Pier saltpans	Jamnagar	14.1.2003	4
Sanctuary saltpans	Jamnagar	14.1.2003	18
Total			1432

grebes was recorded at Charakla Saltpans, near Dwarka (22° 14' N, 69° 01' E); the grebes were seen in the saltpan in three groups of 1000, 375 and 30 individuals each. Grebes observed at the other three sites were found either singly or in pairs.

We also saw one white coloured Black-necked Grebe, with some black splashes on the head and sides of its body, amongst a group of thousand birds at Charakla Saltpans. The white grebe was at ease with the other grebes with normal plumage and was also seen diving occasionally like its conspecifics.

The highest concentration of Black-necked Grebes (201) was first reported in December 1996 from Charakla Saltpans (Parasharya *et al.* 1998). Earlier, about 50 grebes (Balar and Balar 1999) had been spotted on January 10, 1996; and Bhaskaran (1996) had spotted about 51 grebes in October 1996. Since 1996, significantly higher concentrations of grebes have been observed every year at the same site by the birdwatchers of Gujarat. Balar and Balar (1999) reported about 800-1000 grebes in January 1999; they had taken several photographs, one of which was published in the Times of India dated June 26, 1999.

Two hundred and fifty birds represent 1% biogeographical population of Black-necked Grebe (Wetlands International 2002). A site becomes internationally important if it supports more than 1% biogeographical population of any one species of waterfowl regularly. Charakla Saltpans seems to be an internationally important site for Black-necked Grebe as it has supported high concentrations of the species on a regular basis since 1996.

All the present sightings are on the Gulf of Kachchh (Jamnagar district) or in its vicinity (Porbandar district). Parasharya and Mukherjee (1998) had also reported concentration of grebes around these two districts. Grimmett *et al.* (1998) and Kazmierczak (2000) have reported regular occurrence of grebes along the coast of the Gulf of Kachchh. Hence, all the saltpans along the southern coast of the Gulf of Kachchh should be checked for the occurrence of Black-necked Grebe.

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7. MIGRATION OF BLACK-EARED OR LARGE INDIAN KITE *MILVUS MIGRANS LINEATUS* (GRAY) FROM MONGOLIA TO NORTH-EASTERN INDIA

The Black-eared or Large Indian Kite *Milvus migrans lineatus* (Gray) is regarded as a resident with unclear abundance in Assam (Choudhury 2000) while the subspecies *govinda* is among the most abundant birds. Ali and Ripley (1987) had quoted Baker (FBI No. 1788, Vol. 5: 124) about its breeding in the hills, south of the Brahmaputra river and mentioned that elsewhere in India (excluding extreme south) it is a winter visitor in small numbers. On migration they stated, referring Frank Ludlow (*Ibis* 1937: 493), coming from north through Bhutan on September 5. Thus, little data is available on its migration.

A single specimen of *Milvus migrans lineatus* was captured live by a villager near Loktak Lake in Manipur on October 22, 2001. It was near Mayong Imphal (24° 36' N, 93° 54' E) towards east of the lake at an elevation of 790 m above msl. Efforts to buy the bird and release it back did not succeed as the owner refused to sell it. The bird had a ring marked "Hiddensee Germania EA 096970". After a lot of

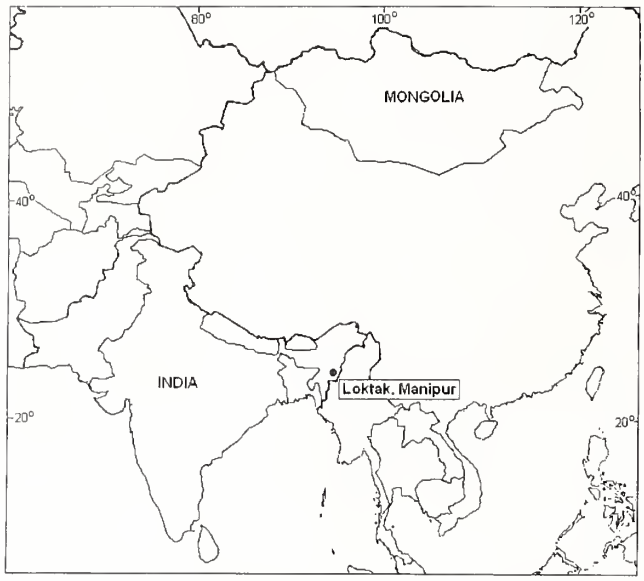

Fig.1: Map showing the places mentioned in the text

communication, I learnt that the bird was ringed in Mongolia at 44.25° N, 105.19° E, as a nestling on July 18, 2001 on an Elm (*Ulmus*) by Prof. Dr. Michael Stubbe from the University of Halle, Germany.

This was perhaps the first concrete evidence of migration of *Milvus migrans lineatus* from Mongolia to India.

I thank Dr. R.K. Ranjan Singh of Manipur University for locating the ringed bird and informing me. I also thank Jessica Scheider of Frankfurt for confirming the Mongolian information.

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8. MAMMALIAN PREY SPECIES OF THE FOREST OWLET *HETEROGLAUX BLEWITTI* HUME

The Forest Owlet (*Heteroglaux blewitti*) is one of the least known endemic birds of India. It was considered to be extinct for 113 years until its rediscovery in Toranmal Reserve Forest in Maharashtra (King and Rasmussen 1998). Little has been published on the diet of the Forest Owlet (Rasmussen and Ishtiaq 1999; Ishtiaq *et al.*2002). Earlier studies on the foraging ecology of the Forest Owlet reveal that its food consists of 58.8% skink and other lizards, 15.8% field mice and rats, 2.3% birds, 1.8% grasshoppers, 0.6% caterpillars, 0.6% frogs and 20.5% unidentified prey item (Ishtiaq *et al.* 2002). However, according to the pellet analysis by Jathar and Rahmani (2002), insects is the main diet of the Forest Owlet (41%) followed by mammals (36%), reptiles (16%) and remaining (7%) comprised of birds, arachnids and amphibians. Information on mammalian prey species of the Forest Owlet is anecdotal. The primary aim of this note is to describe mammalian prey species of the Forest Owlet.

The study was conducted in Toranmal Reserve Forest of Shahada *taluk*, in Nandurbar district, Maharashtra, India. The study area lies between 21° 47' N and 74° 28' E to 21° 49' N and 74° 29' E, at an altitude of 450 m to 550 m. Toranmal lies in the Akrani hills of west Satpura mountain ranges.

The Forest Owlet is found in open wooded habitat near stream beds dominated by Teak and other tree species such as *Boswellia serrata, Anogeissus latifolia*, *Lanea grandis*, *Lagerstroemia parvifolia* interspersed with low lying bushes and grass.

Pellets were collected regularly from four pairs at four different locations for seventeen months (November 2001 to June 2003). The location coordinates, altitude and numbers of pellets were recorded. All the pellets were collected from a diurnal roost of Forest Owlet. Efforts were made to collect a large number of pellets and care was taken to avoid collection of pellets of other owl species. All pellets were sun-dried, numbered and kept in polythene bags, with collection data.

The pellets were dissected using standard techniques (Yalden and Morris 1990). The material was segregated according to class: arachnids, insects, amphibians, reptiles, birds and mammals. Prey items were identified to the finest possible taxonomic level at the Zoological Survey of India, Pune by the second and third author. Jawbone and skull pieces showing key characters like molars, incisors, nasals, pallet, mandibles were used for identifying mammals up to species level, using Corbet and Hill (1992) and Agrawal (2000).

Table 1: Percentage occurrence and biomass of the mammalian prey species of the Forest Owlet found in pellets (n= 193)

Species	No. of individuals (a)	Frequency of occurrence	Total frequency	Mean weight of animal (in grams) * (b)	Total Biomass of the animal (in grams) (a x b)	Percentage of Biomass	Total biomass
Insectivores							
Suncus spp.	7	3.63	17.10	-	-	-	37.23
Suncus stoliczkanus	10	5.18		5	50	6.18	
Suncus etruscus	9	4.66		10	90	11.13	
Suncus murinus	7	3.63		23	161	19.92	
Rodents							
Mus spp.	89	46.11	59.06	-	-	-	62.71
Mus booduga	9	4.66		10	90	11.13	
Mus musculus	4	2.07		17	68	8.41	
Mus phillipsi	4	2.07		17	68	8.41	
Mus saxicola	3	1.55		26	78	9.65	
Mus platythrix	1	0.52		26	26	3.21	
Tatera indica	1	0.52		163	163	20.17	
Vandeleuria oleracea	1	0.52		14	14	1.73	
Rattus sp.	2	1.04		-	-	-	
Unidentified	46	23.83	23.83	-	-	-	
Total	**193**			**311**	**808**		

* Weights of all insectivores were taken from BNHS collection records and weights of all rodents were taken from Ellerman (1961)

Analysis of the 371 pellets revealed a diet comprising 574 prey items of which 193 were small mammals. Thus, mammals accounted for 33.62% of the prey. Altogether eight species of rodents (mice and rat) and three species of insectivores (shrews) were recorded from the pellets. 89 samples of mice *Mus* could not be identified up to species level and 46 samples were not identified due to lack of jawbones and skulls.

Prey frequency and prey biomass

Mus spp. were the most frequent prey of the Forest Owlet during the study period. *Suncus stoliczkanus* was the second most frequent prey followed by *Mus booduga* and *Suncus etruscus* (Table 1).

Though relative abundance of prey species within the Forest Owlets territory was not estimated, it appears that small mammals especially *Mus* spp. were hunted in proportion to their relative abundance. Studies on the Barn Owl *Tyto alba* (Evans and Emlen 1974) have shown that the change in consumption of prey is related to the periodic change in the population of the prey species. The relationship between rainfall and population increase in rodents and their relative consumption by Barn Owls has been shown by Debrot *et. al.* 2001.

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9. SIGHTING OF LONG-EARED OWL (*ASIO OTUS*) IN BANNI REGION OF KACHCHH DISTRICT, GUJARAT, INDIA

The Long-eared Owl *Asio otus* is an uncommon winter visitor to India (Kazmierczak and Singh 1998). On January 17, 2000, we were surveying in the Andaui village of Banni region of Kachchh, Gujarat, close to the Greater Rann, for rare and endangered plants. Standing on a dry village pond, one of us (JJ) saw something that resembled a dead stump of a branch among the foliage of one of the *Acacia nilotica* trees. On a closer look, we found it to be a bird, and that too an owl.

The owl was brownish orange in colour, with heavy streaks on the breast, belly and flanks, and to some extent on the upper parts. It had long ear tufts with an orange brown facial disc and orangish brown eyes.

On scanning the other trees nearby, we spotted three more birds. They were perched on branches close to the main trunk. The average height of the trees was 3 m. The birds were perched between 1 m to 2.5 m from the ground, with dense cover on all sides. The canopy was very dense, as the branches of the trees had grown after the villagers had lopped them. These have probably given them adequate protection and cover from disturbance, especially from crows. We could approach the edge of the canopy (< 2m) without disturbing the birds.

The Long-eared Owl is listed in Appendix A in THE BIRDS OF KUTCH (Ali 1945). Ali has mentioned that sightings of this bird were reported from Kutch by Dr. F. Stolickza and A.O. Hume in the early 1870s, but the species was not spotted during his survey.

This species has been reported to be a resident migrant, breeding in Baluchistan and Kashmir up to *c.* 2000 m and wintering in Pakistan and N. India (Ali and Ripley 1995). Grimmett *et al.* (1999) call the species a winter visitor to Pakistan and northwest India, also with records of breeding.

It was said to occur in the hilly forest in summer and grassy low-land jungle (Ali and Ripley 1995) and among stunted trees and popular plantations (Grimmett *et al.* 1999) in winter. Our sighting was in a small patch of *A. nilotica* forest, which had been severely lopped, but had grown again into a thick closed canopy, located at the edge of the Rann in the once extensive Banni grasslands.

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10. BREEDING OF SAND MARTIN (*RIPARIA RIPARIA*) ON THE BANKS OF RIVER GANGA IN CHILLA PART OF RAJAJI NATIONAL PARK, UTTAR PRADESH

During my study on the elephants in Rajaji National Park, in the Siwalik hill of Uttaranchal, in May 1991 and 1992, I located a small nesting colony of Sand Martin (*Riparia riparia*) on the banks of River Ganga in the Chilla part of Rajaji National Park. There were 14 nest holes of the Sand Martin on the loamy soil of the western banks of River Ganga.

All the nests were at 1.5 to 2 m from the base of the bank, with 0.5 to 1 m bank above the nests. As the water was flowing below the nesting site, it was difficult to approach the nests. All nests were active as the birds were frequently visiting them. The riverbank above the colony was covered with very dense *Lantana camara* bushes. The approach from that side was very difficult as the scrub extended for about 25 m towards the landside. The nesting location selected by the species is probably such that there is no disturbance or danger from any front, which is critical when selecting a nest site.

The Sand Martin is not known to breed in this part of the country; it is said to breed only in the Himalaya from Quetta eastwards, northeast hill states, West Bengal up to 4500 m (Ali and Ripley 1995; Grimmett *et al.* 1999).

This is the first report of Sand Martin breeding in the northwestern part of India more specifically in the Siwalik on the banks of River Ganga.

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11. SIGHTING OF SAND MARTIN (*RIPARIA RIPARIA*) AND PLAIN MARTIN (*RIPARIA PALUDICOLA*) IN BANASKANTHA DISTRICT, NORTH GUJARAT, INDIA

During our survey in Banaskantha district for rare and endangered plant and animal species, we observed two species of martins. One species, of which four birds were seen, had very distinct brownish grey breast markings, resembling a half collar along with the white throat and belly, and the brownish grey upper parts, and a deeply forked tail. From the colour and other characters, it appeared to be the Sand Martin (*Riparia riparia*). The second species, of which two individuals were sighted, had a very light brownish grey throat and breast with dull white belly and less forked tail. It was the Plain Martin (*Riparia paludicola*). These species are familiar to one of us (JJ), as both were frequently seen in the Siwalik hills and outer Himalaya, where JJ worked for many years.

The Sand Martin is distributed in the Himalaya from Quetta eastwards, NE hill states, West Bengal up to 4500 m and also said to winter in Pakistan, south to Makran, Madhya Pradesh, Bihar and Sri Lanka (Ali and Ripley 1995). It is a winter visitor and fairly common (Kazmierczak and Singh 1998) and has been noted west to Gujarat and found to breed in northeast India (Grimmett *et al.* 1999). We sighted the birds flying over a small dam, behind a rest house, in the Jessore Sloth Bear Sanctuary in Banaskantha district of North Gujarat. The water body was surrounded by hills covered with dry deciduous and scrub forests. The bird is reported to stay around streams and lakes (Ali and Ripley 1995), large water bodies, around rivers and streams in summer (Grimmett *et al.* 1999).

The presence of Plain Martin in the Kachchh region has been established by Hume (1875, *Stray Feathers, Vol. iii*), mentioned in Ali (1945). According to Gallagher and Woodcock (1980), this species is found to be a migrant to India. It is distributed in Pakistan and N Subcontinent roughly south to Bombay (=Mumbai), Madhya Pradesh, Orissa to NE hill states and Bangladesh (Ali and Ripley 1995). It is said to be resident and subject to local movement (Kazmierczak and Singh 1998) mainly found in N and C Subcontinent (Grimmett *et al.* 1999). This species was sighted in the eroded riverine patch in a thorn forest, near Kotda village in Palanpur taluka of Banaskantha district, North Gujarat. This forest was dominated by *Acacia nilotica* interspersed with *Prosopis chilensis* on gentle undulating terrain.

Our sighting is the first record of these two species in the Banaskantha district of North Gujarat. The only other sighting of both the species was in the central part of Gujarat (Grimmett *et al.* 1999).

May 26, 2003

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12. OCCURRENCE OF DESERT WHEATEAR *OENANTHE DESERTI* AND ISABELLINE WHEATEAR *OENANTHE ISABELLINA* IN MAHBUBNAGAR DISTRICT, ANDHRA PRADESH

On January 14, 2003 we visited Palmakole Tank (17° 9' N, 78° 19' E; 30 km on National Highway 7, Hyderabad-Bangalore), Mahbubnagar district, Andhra Pradesh, for the Asian Waterfowl Census. The water level was very low. In fact, the tank was so shallow that villagers were walking right across it, fishing along the way. Agriculture (pulses, greens, vegetables, etc.) was carried out on the north, east and southeast margins of the tank, above the high water mark. There was a masonry bund on the west and a large industrial unit (Saint-Gobain Vetrotext) in the south-west. The strip of land between cultivation and the high water level had the occasional borrow-pit and was generally barren and stony, the ground being dotted with grit and boulders of all sizes, some of which were being chipped and taken away by stone-masons (illegally?), with dusty stretches of dry coarse grass in between. From where the water had recently receded, the earth was covered with close-cropped green grass. Wherever turned, the soil was revealed as black cotton.

While walking towards the water's edge, we spotted a bird on a rock, less than a metre above the ground. It was perched bolt upright, looking in our direction. Its most prominent feature was a black loral streak that joined the black beak with the eye. It was about sparrow-sized with much longer, black legs. The rest of the body appeared a light buff colour, at a distance. When it relaxed, the tail bobbed up and down like a Common Sandpiper *Actitis hypoleucos* Linnaeus, 1758. As we watched, it jumped to the ground and ran quickly and directly up to an insect that it picked up and ate. We suspected that it was an Isabelline Wheatear *Oenanthe isabellina* (Temminck, 1829), after looking up Krys Kazmierczak's FIELD GUIDE (2000), but were not sure, as that work did not show the loral streak prominently enough. However, a diagram of the bird was made on the spot. We lost sight of this bird but then spotted another unfamiliar species for these areas, not far away, upon another rock. This was unquestionably, a male Desert Wheatear *Oenanthe deserti* (Temminck, 1825) (Grimmett *et al.* 1999; Jonsson 1996; Lewington *et al.*).

In the meantime, we spotted the suspected Isabelline Wheatear once again and drew another quick field sketch. Further notes were taken. A white supercilium was clearly visible over the loral streak, ending just beyond the eye. The crown, nape, mantle and folded wings were a light sandy brown. The sides of the head (ear coverts) were pinkish-buff, as were the breast and a thin area along the flanks. The throat and abdomen were dirty white. In flight, which was generally close to the ground and straight, a broad black terminal band on the tail contrasted strongly with white upper tail feathers. The bird, when alert, stood very upright, as already noted. For a short while, the Isabelline gave vent to a thin warble-like song, which was heard by both of us. Both the Desert Wheatear and the Isabelline Wheatear frequently fed close to each other.

We visited the area again on January 19, 2003, and saw and photographed both the species. Copies of the pictures were emailed to Bill Harvey, Krys Kazmierczak and Sudhir

Vyas, who confirmed our identification by email.

Ali and Ripley (2001) give the distribution of the Desert Wheatear as, "...India east to Bihar and south to Maharashtra, eastern Tamil Nadu... and Sri Lanka..." Ali and Whistler's (1933) [Pp. 382, "*Oenanthe deserti atrogularis* (Blyth)" = *O. d. deserti* (Temminck 1825)] is the only record of the Desert Wheatear from present day Andhra Pradesh. In that paper Ali and Whistler inform (Pp. 382) "several Wheatears were observed along the route from Nirmal to Utnoor (via Talâmadri village) between October 12 and 15 [1925]. I did not, however, come across this bird anywhere within the State [erstwhile Hyderabad State] in the course of the present Survey." However, in his unpublished notebooks (photocopy of manuscript held by senior author), Ali states after the above note, "...(Note from old diary - doubtful!?)." Neelakantan, Sashikumar and Venugopalan (1993) reported sightings from Kerala, "...a female in January 1988 at Tenari (Elappully, Palghat Dt.) and a single female 'in the next two winters' and 2 females in 'the winter of 1990-91.'...a Desert Wheatear at Madayippara (Cannanore Dt.) on 17th August, '88." Surprisingly, this species is not even mentioned in the "Revised and Enlarged" edition of Ali's THE BIRDS OF KERALA (1999). The present sighting of the species is another instance of its occurrence outside its known wintering range.

Ali and Ripley (2001) record the distribution of the Isabelline Wheatear as, ".... the plains of northwestern India including N. Gujarat..., straggling east and southeast to Varanasi and Sehore, and south to Ahmednagar... and Pune...Possibly a vagrant in Nepal... Recorded in Maldive Islands in November..." Lainer (1999) gives it the status of "Vagrant," for Goa, informing of "four sightings of up to 5 birds on a barren lateritic plateau near the coast, at Sancoale (Marmagoa), in November-December of three consecutive years in the mid-eighties." Robson (2000) records a single specimen on February 9-10, 2000 at Baga Fields, Goa. In view of these records, the present observation is a considerable extension of range for this species.

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13. NEW RECORDS OF BIRDS IN PERIYAR TIGER RESERVE, THEKKADY, KERALA

Periyar Tiger Reserve, a well known wildlife sanctuary in India, is situated in the Cardamom and Pandalam hills of the southern Western Ghats between 9° 15'-9° 40' N and 76° 55'-77° 25' E, covering an area of 777 sq. km. Robertson and Jackson (1992) recorded 266 bird species and Srivastava *et al.* (1993) recorded 249 species in Periyar Tiger Reserve. Santharam (1996) added three species and the existing records indicate the presence of about 314 species of birds in Periyar Tiger Reserve.

An ornithological survey was carried out in the Periyar Tiger Reserve during February 2002. Four new bird species were sighted during the survey, namely Common Greenshank

(*Tringa nebularia*), Malabar Pied Hornbill (*Anthracoceros coronatus*), Ashy-crowned Sparrow-Lark (*Eremopterix grisea*) and Chestnut-bellied Nuthatch (*Sitta castanea*). We also sighted the Spot-billed Pelican (*Pelecanus philippensis*) during January 2001 near Periyar lake and the Pheasant-tailed Jacana (*Hydrophasianus chirurgus*), Purple Heron (*Ardea purpurea*) and Purple Moorhen (*Porphyrio porphyrio*) during February 2003 in a small wetland near the forest check post at Thekkady. The new additions bring the total bird species found in the Periyar Tiger Reserve to 322.

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14. OCCURRENCE OF THE TWO-SPOT GOURAMI *TRICHOGASTER TRICHOPTERUS* (PALLAS) IN PORUR, CHENNAI, TAMIL NADU, INDIA

Introductions, intentional or accidental, of exotic species of plants and animals into other countries or continents are not uncommon. This has sometimes resulted in the domination of exotic species over native ones, and among fish, the case of the food fish Mozambique Tilapia *Oreochromis mossambica* is well known.

In this note, I report the occurrence of the Two-spot Gourami *Trichogaster trichopterus* (Pallas), a native of Thailand, Malaysia, IndoChina and Indonesia (Hervey and Hems 1966; Dawnes 1998), in the wild in the suburbs of Chennai, Tamil Nadu, which is probably the first record of the species in Indian waters. I recorded good numbers of this species in drying pools in a low-lying residential area in Porur, a suburb to the west of Chennai after the northeast monsoon of 2002 and 2003. This area forms the drainage areas of the runoff of the waters of Porur Lake, a small lake that meets a part of the water requirements of Chennai.

Chennai is one of the major distribution and breeding centres of aquarium fish in India and the occurrence of the Two-spot Gourami in Chennai waters is probably an accidental or intentional outcome of ornamental fish culture. The record of the species in Porur poses two main questions. Does the species also occur in other areas of Chennai and what is the impact of the species on native species? With the spread of ornamental fish culture in India, especially in recent times, Indian waters will probably witness the entry of more exotic fish species.

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15. EXTENSION OF RANGE OF *NEMACHEILUS KERALENSIS* (RITA & NALBANT) AND *PUNTIUS OPHICEPHALUS* (RAJ) TO RIVER MEENACHIL, KERALA (INDIA)

The rivers of Kerala harbour a rich and diversified fish fauna (Day 1875-1878; Pillai 1929; John 1936; Hora and Law 1941; Raj 1941; Chacko 1948; Silas 1951). However, little information is available on the present status of the fresh water fishes of Kerala, which are prone to various types of threats such as over exploitation, introduction of exotic species, habitat destruction and pollution. The Travancore region in the southern Western Ghats of Kerala has been noted for its richness in number and variety of fresh water fish. The fresh water fish fauna of this geographical region is

also well-known for its high degree of endemism. The river Meenachil is known to harbour several interesting and important fishes. However, only limited information is available on the present status of diversity, abundance and distribution of fresh water fish fauna of this river. While carrying out survey and sampling in the river system as part of the ongoing NAT-ICAR project on 'Germplasm inventory, evaluation and gene banking of fresh water fishes of Kerala', we identified 24 species of fishes from this river. Among them, *Nemacheilus keralensis* and *Puntius ophicephalus* collected from the Vagamon and Vazhikkadavu areas respectively of the river were found to be new additions to this water body. The available literature revealed that *Puntius ophicephalus* was known, so far, only from the upper reaches of the Periyar and the Pamba river basins, whereas the distribution of *Nemacheilus keralensis* was restricted to Pampadupara at Kallar tributary of Periyar river (Jayaram 1999; Menon 1999).

Order: Cypriniformes
Family: Cobitidae
Subfamily: Nemacheilinae
1. ***Nemacheilus keralensis*** (Rita and Nalbant)

Diagnostic features: Dii,7; P11; Vi,7; A2,5; C17.

An elongated and slender species with a sub-cylindrical body and incomplete lateral line. Dorsal fin with 7 branched rays, inserted nearer to the base of caudal fin than to snout tip. Nostrils close to each other, nearer to eye than to snout tip. Barbels well-developed, nasal barbels extending to eye. Scales small, well developed, imbricate scales all over the body. Body with uniform golden green colour, marked with very narrow brown curly lines and spots arranged in a regular fashion or scattered. Fins golden yellow, caudal fin with irregular spots.

Order: Cypriniformes
Family: Cyprinidae
Subfamily: Cyprininae
2. ***Puntius ophicephalus*** (Raj)

Diagnostic features: D.iii,7; Pi,14; V.i,8; A.ii-iii,5; C.17; L.l. 42.

An elongated and laterally compressed body with a broad and depressed head, and sub-inferior mouth. Dorsal profile slightly more arched than ventral; there are two pairs of barbels. Dorsal fin inserted nearer to tip of snout than caudal fin base. Last unbranched dorsal ray stiff and slightly enlarged but very weak, smooth, articulated in its upper part. Back and fins are golden yellow with brownish tinge. A dark band runs along the lateral line ending at the caudal peduncle. Dorsal and caudal fins golden yellow, while pectoral and ventral fins golden with a reddish tinge. Cheeks shining golden.

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16. RECENT RECORDS ON THE DISTRIBUTION, SEASONALITY AND OCCURRENCE OF REDSPOT BUTTERFLY, *ZESIUS CHRYSOMALLUS* HÜBNER FROM THE LOWER WESTERN HIMALAYA

The Redspot butterfly *Zesius chrysomallus* Hübner (1819) (Lycaenidae: Theclinae: Zesiini) which is endemic to the Indian subcontinent and is part of the Indo-Australian zoogeographic region has a geographical distribution extending into the states of West Bengal (Bholaghat in Malda district), Jharkhand, Orissa (Ganjam and Sambalpur) and Peninsular India (Bombay (=Mumbai), N. Kanara (Karwar), Coorg, Bangalore, the Nilgiris and Travancore) (Fig. 1) where its status is not rare. It also occurs as a locally common species in Sri Lanka (De Niceville 1890; Betham 1891; Swinhoe 1910-11; Evans 1932; Wynter-Blyth 1957; D'Abrera 1986). The female is larger than the male and is totally unlike in appearance, it being bluish with three tails on the hind wings, while the male is a bright copper colour with only 2 hind wing tails (Betham 1891). A female of this species (wingspan 37 mm; dated: November 12, 1913) from Gonda District of Uttar Pradesh state (northern India), and a male (wingspan 34 mm; dated March 3, 1919) collected from Colombo, Sri Lanka are present in the 'Collection' of the Forest Research Institute, Dehradun. Besides, it has also been reported from the Tarai region of Nepal (Chitwan District) as a rare species in riverine forest and water habitats (Smith 1989 and 1997). It is known to prefer jungle country in areas with fairly heavy rainfall and neither sex visits flowers much, but both have been observed at moist patches. The females prefer flying near the wet ground while the male darts about amongst the leaves of trees (Betham 1891). The eggs are laid in the vicinity of red tree ant nests. The ants tend both the larvae and pupae constantly; the pupation takes place inside the ant's nest. Its food plants recorded in literature so far are: *Terminalia paniculata, T. alata, Pterocarpus marsupium, Psidium guajava, Loranthus* spp. (Wynter-Blyth 1957) and *Xylia dolabriformis* (Sevastopulo 1973).

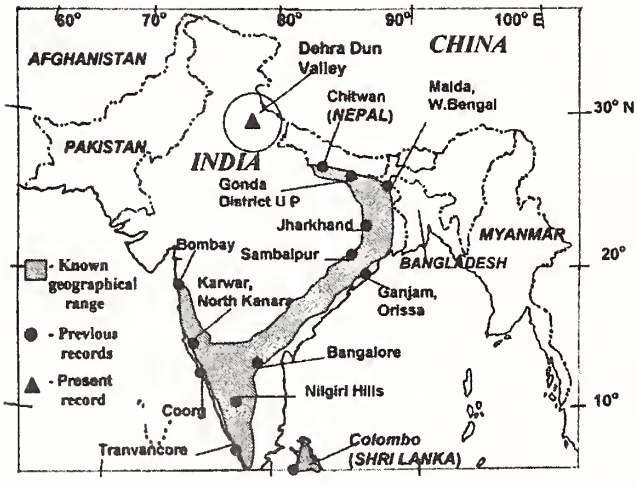

Fig. 1: Map depicting the geographical distribution of Redspot butterfly, *Zesius chrysomallus* Hübner in the Indian subcontinent and collection sites as mentioned in the text

Recently, this butterfly was recorded from Dehradun valley (30° 00' N to 30° 35' N and 77° 40' E to 78° 15' E; Uttaranchal State). One female (wingspan: 38 mm) was collected from a moist patch on the ground in the New Forest campus (670 m) during April 1989 (Singh 1999).

Mackinon and De Niceville (1899) who studied the butterflies of Mussoorie and its neighbouring regions for 11 years (1887-1898) have not recorded this species in Dehradun district. As there were no previous records of this butterfly from the western Himalaya, it was decided that extensive surveys should be carried out in the Dehradun valley to learn more about the distribution, seasonality and relative occurrence of this butterfly in the lower west Himalayan tracts.

Present Survey

Study area: The Dehradun valley lies between the west Himalayan mountain ranges in the north and the Siwalik range running parallel to it in the south at a mean altitude of 485 m and covers an area of *c.*1920 sq. km. In the west it is bordered by the river Yamuna and in the east by the river Ganga. The valley is also well watered by perennial streams. The mountain slopes on both sides (north and south) of the valley are covered with pure and mixed forests dominated by Sal *Shorea robusta* [tropical moist deciduous Sal forests (TMDSF) (Champion and Seth 1968)]. These forests cover 51-58% of Dehradun valley (Anon. 1995). However, the flat areas in the central part of the valley, which were once under Sal forest cover are today under different land use practices: irrigated and cultivated agricultural land (wheat, sugarcane, paddy, maize, pulses, peas, ginger, turmeric and yams); agroforestry plantations (mainly poplar, eucalyptus and sisham); tea gardens (with *Dalbergia sissoo* as shade trees); fruit orchards (mango, litchi, guava, plum, peach, pear, citrus fruits etc); urbanized areas (densely constructed buildings in the city); cantonments (spaced houses/big buildings having lawns, gardens and orchards) and scrubland.

The valley receives approximately 200 cm rainfall annually, mostly during the monsoons (June-September). The temperature fluctuates between -1°C to 43.9°C from winter to summer.

Study sites: A total of 8 sites were selected for the study in the entire Dehradun valley. These included, 6 sites in the TMDSF which were located at Karvapani, Timli, Thano, Baarwala, Jhajra and Lacchiwala forest ranges, of the Dehradun forest Division (Karvapani and Timli lie on the northern side of Siwalik mountains, Thano and Baarwala touch the south facing mountain slopes of lower Himalayan ranges, Jhajra and Lacchiwala are in the flat areas in the central part of the valley). Each forest site covered a minimum of 4 sq. km. The two sites outside TMDSF were New Forest Campus and Hathibarkala estate, which lay in the cantonment areas (having gardens, big fields and lawns, fruit tree orchards, agriculture, plantations, tree avenues, buildings, etc) and covered the same area.

Sampling: Sampling was based on the methodology proposed by Blair and Launer (1997) Each site was sampled for butterflies during sunshine for 2 hours for two successive days, at each site. Each site was divided into 4 plots (2 ha each). Each site was sampled once in 2 months for 2 years (July 2000-August 2002). A total of 10 samplings for each site were obtained in 2 years. All the three strata (canopy, middle story and ground) were sampled for butterflies with the help of binoculars and butterfly nets. The number of each butterfly species was recorded by walking on a jungle trail in a linear transect for half an hour in each plot. Voucher specimens were collected for authentic identification. Specimens were identified by comparing with the collection at Forest Research Institute, Dehradun.

Relative occurrence: The relative occurrence of individual butterfly species for the entire year (study period) was categorized into 5 different classes: Rare (1-8 counts); Not rare (9-40 counts); Fairly common (41-80 counts); Common (81-160 counts) and Very common (>160 counts). This was based on the presence of a species on a scale of 1-320 counts (4 plots x 8 sites x 10 sampling periods) [where a species can take a minimum score of 1 (an individual species recorded only once in a plot at a single site during the entire sampling period) and a maximum score of 320 (an individual species recorded every time in every plot at every site during the entire sampling period)].

Distribution, seasonality and occurrence: *Zesius chrysomallus* was collected and observed on only two occasions at only 2 sites, namely site-8 (Hathibarkala estate: 730 m, on March 24, 2001, one male; wingspan: 34 mm) and at site 4 (Baarwala: 700 m, on May 22, 2002, two males; wingspan of one: 32 mm), during the sampling period. As this butterfly was spotted on only 2 occasions in the total samplings, it was categorized as a 'rare' species in the valley.

Habits and Habitat: A male was observed basking in the sunshine on a leaf of a small *Nyctauthes arbor-tristis* (Harsingar) tree, in the morning at Hathibarkala estate. At Baarwala, both the individuals were caught feeding on nectar from *Syzygium operculata* trees growing beside a stream in an open degraded Sal forest in the company of Large Oak Blue *Arhopala amantes* Hewitson (Lycaenidae) in the afternoon. The *S. operculata* at this site also harboured *Oecophylla smaragdina* – a species of red tree ant, and the epiphyte *Loranthus longiflorus* with which its larvae are associated.

The observations made herein refurnish recent evidence on the northwestern limit of the geographical distribution of this species, which now extends up to Dehradun valley in the lower western Himalaya rather than up to Nepal *tarai* in the lower Central Himalaya, as known previously. These observations also reveal that *Z. chrysomallus* is a rare species in Dehradun valley occurring between 650 and 800 m altitude with flight period during March to May. The availability of a large number of its food plants like *Psidium guajava* (cultivated), *Terminalia alata* and at least 2 species of Loranthus namely, *L. longiflorus* and *Taxillus vestitus*, in the Dehradun valley offer sufficient chance for this butterfly to breed and survive in the lower western Himalaya. *Z. chrysomallus* specimens will be deposited at the FRI collection after completion of this study.

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17. OCCURRENCE OF *GRAPHIUM DOSON* COMMON JAY BUTTERFLY, FAMILY PAPILIONIDAE, IN MUMBAI, MAHARASHTRA

The Family Papilionidae in Mumbai is represented by ten species of butterflies (Best 1951) of which three species belong to genus *Graphium*. Among these, the Tailed Jay *G. agamemnon* is the most common and found all over the city, in the suburbs and the outskirts of Sanjay Gandhi National Park. The remaining two species, Spot Swordtail *G. nomius* and Common Blue Bottle *G. sarpendon* are restricted to forest and green patches in and around the Sanjay Gandhi National Park. On December 8, 2002, while walking along the roadside at Goregaon – a suburb of Mumbai, at 1030 hrs, we observed two butterflies sucking liquid from a mud puddle. On a closer look they were identified as the Common Jay *Graphium doson*.

Wynter-Blyth (1957) reports the distribution of *G. doson* as Ceylon (=Sri Lanka), South India to Bengal and from eastwards of Kumaon to Assam and Burma (=Myanmar). Talbot (1939) has described three subspecies – *G. doson doson* (C & R Felder) from Sri Lanka, *G. doson eleius* (Fruhstorfer) from Southern India to Bengal and *G. doson axion* (C & R Felder) from Kumaon (N. India) to Myanmar.

The Common Jay has not been reported from Mumbai region by earlier workers, and this is the first record of its occurrence from Mumbai. One of us (ST) observed the breeding of this species during December 2002. She collected a larva feeding on leaves of Mast tree *Polyalthia longifolia* at Jogeshwari, a suburb of Mumbai. The larva was reared *in situ* by feeding fresh leaves of *P. longifolia*. The larva pupated on December 4 and the butterfly that emerged on December 14, 2002 was identified as the Common Jay *G. doson*.

Bell (1912) has described the Common Jay as a sun-loving butterfly, sipping moisture on roads and in beds of nullahs in hot months and rains. According to him, it seems to be confined to hills and jungles from sea level upwards. Its occurrence along the busy city roads of Mumbai and breeding in this habitat is noteworthy.

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18. CANNIBALISM OBSERVED IN THE MONKEY PUZZLE BUTTERFLY *RATHINDA AMOR* (LEPIDOPTERA: LYCAENIDAE)

The food plants of the Monkey Puzzle butterfly *Rathinda amor* belong to families Rubiaceae, Dipterocarpaceae, Euphorbiaceae, Loranthaceae, Sapindaceae and Mylaceae (Bell 1919). The larvae are pinkish-red, a perfect

camouflage for the leaves on which they feed. They become green in colour when they feed on green leaves. They grow to about 1.5 cm to 2 cm in length and then settle down for pupation. They emerge after about 7 days from the date of pupation.

Omnivorous feeding habit of the herbivore larvae has been recorded earlier (Bell 1919). However, there is no information on the cannibalistic behaviour of the Monkey Puzzle larvae. This strange behaviour was observed in the larvae reared in captivity.

Three larvae were reared in a plastic container in which ample leaves of *Ixora* spp. were provided as food. On completion of the last instar, one larva anchored itself for pupation on the wall of the plastic container. After sometime, I observed the other two larvae feeding (one on either side) on the larva which was pupating. They devoured the larva within an hour and a half and resumed feeding on the leaves of *Ixora* spp. After about two and a half hours both the larvae anchored themselves on the wall of the plastic container for pupation.

Cannibalism in butterfly larvae is not uncommon. Chaturvedi and Haribal (1991) have reported cannibalism in the Common Tiger *Danaus genutia* and the Blue Tiger *Tirumala limniaceae* on *Marsdenia tenacissima*. De Niceville (1890) has reported cannibalism in Lycaenids.

Though cannibalism is seen in Lycaenids, it had not been specifically recorded, so far, for *Rathinda amor*.

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19. MUKURTHI NATIONAL PARK: A MIGRATORY ROUTE FOR BUTTERFLIES

Butterfly migration often takes the form of persistent flight in one direction over long distances in large numbers and such flights are clearly different from local flights around the breeding area, which are associated with feeding, mating and egg laying. Sixty of the worlds 250 migratory butterfly species are reported from India. These species belong to the families Pieridae, Danaidae, Nymphalidae and to a lesser extent, the Lycaenidae and Hesperidae (Gunathilagaraj *et al.* 1998).

On November 25, 2002 during my fieldwork in Bangitabal valley of the Mukurthi National Park in the Nilgiris district of Tamil Nadu, I saw thousands of butterflies, flying to the southwest of the valley towards the Silent Valley National Park of Kerala. I observed this process of migration from around 0830 hrs till 1700 hrs.

In the migratory swarm, the Blue Tiger (*Tirumala liminiace*) was the predominant species followed by the Danaid Eggfly (*Hypolimnas misippus*) and the Great Eggfly (*Hypolimnas bolina*) as was evident from the number of males in the swarms (since the Danaid Eggfly mimics the Plain Tiger and female of the Great Eggfly mimics the Common Crow *Euploea core*). Other species recorded were the Common Crow, the Tailed Jay (*Graphium agamemnon*), the Common Jezebel (*Delias eucharis*), the Common Blue Bottle (*Graphium sarpedon*), the Plain Tiger (*Danaus chrysippus*) and three unidentified species.

The migration was observed again on the next day in the same direction. Most of the butterflies flew very close *c.* 2-5 m above the grassland. Interestingly, many insectivorous birds such as Pied Bushchat (*Saxicola caprata*), Nilgiri Pipit (*Anthus nilghiriensis*), Tickell's Warbler (*Phylloscopus affinis*), Greenish Leaf-Warbler (*Phylloscopus trochiloides*) and Oriental White-eye (*Zosterops palpebrosus*) were trying to capture some of these fluttering butterflies. These birds were perched on Rhododendron (*Rhododendron nilgiricum*) and took off often to capture the ones flying close by. Occasionally, some butterflies rested on the vegetation. The butterflies flew in a scattered manner and in mixed composition. Large numbers migrated during the bright hours of the day with good sunshine, the numbers dropped considerably in the evening. These swarms generally migrated along the valley rather than the ridges.

I presume that Mukurthi National Park is a major migratory route for these species. It is also the least disturbed region of the Nilgiri hills without any anthropogenic pressure and appears to be quite safe.

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20. FIRST RECORD OF *SCATELLA STAGNALIS* (FALLÉN) (EPHYDRIDAE: DIPTERA), FROM INDIA

Scatella stagnalis (Fallén) is a schizophoran, acalyptrate dipteran belonging to the superfamily Drosophiloidea. The genus *Scatella* Robineau-Desvoidy, reportedly has 3 species from the Oriental region, namely *Scatella bullacosta* Cressor (Taiwan), *Scatella scantipuli* Schiner (St. Paul's Island) and *Scatella stagnalis* (Fallén), which is more widespread in distribution, being recorded from four zoogeographical areas, namely Oriental (Taiwan) Holarctic, Ethiopian and Neotropical regions. The diagnostic features of the species are: black body with pruinose face; dorsum of abdomen shining dark brown; wings usually with 2 or more spots in R_{2+3}.

Scatella stagnalis was first reported by Fallén from its type locality, Sweden; the only report from the Oriental region is from Taiwan (former Formosa).

While studying the Ephydrid collection of the National Zoological Collection at the Headquarters of the Zoological Survey of India, Kolkata, we came across a female specimen of this species, collected by A.P. Kapoor on 21.xii.1956, from Eden Gardens, Kolkata, West Bengal (22° 34' N; 88° 27' E). This species was diagnosed by W. Wirth and was not published anywhere. Moreover, no reports of this species from any other state or region of India or from the Indian subcontinent were found.

During a recent survey in the Nepli Reserve Forest and Sukhna Wildlife Sanctuary of Chandigarh (33° 44' N; 76° 52' E), one of us (P. Parui) collected 15 specimens of *Scatella stagnalis* (Fallén). The flies were collected from the barren bed of a water canal, which was then dry, but usually serves as a forest water outlet. The flies were found resting on the bare canal bed.

The present communication is of importance as it is the first record of this species from two different zones (north and east) of India.

***Scatella stagnalis* (Fallén)**

1813. *Ephydra stagnalis* Fallén, K. *Svenska vet. Akad. Handl.*, (3): 248, type-loc: Sweden

Material examined: 1 ♀, Eden Gardens, Kolkata, West Bengal, 21.xii.1956, coll. A.P. Kapoor; 15 exs; Nepli Reserve Forest, Chandigarh, 6.ii.2002, coll. P. Parui.

Distribution: INDIA: Chandigarh; West Bengal.

Elsewhere: Taiwan; Holarctic; Ethiopian; Neotropical.

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21. ADDITION TO THE MANTID FAUNA OF SANJAY GANDHI NATIONAL PARK, MUMBAI AND SOME NEW RECORDS FROM MAHARASHTRA

A note on mantid fauna of Sanjay Gandhi National Park (SGNP), Mumbai, with some new records for Maharashtra state was published by Chaturvedi and Hegde (2000). Recently, Ghate and Ranade (2002) reported 44 species of mantids from Maharashtra. During further observations and studies on the mantid fauna of SGNP and other parts of Maharashtra, we found seven new records not reported by Ghate and Ranade (2002); these include specimens from the earlier collection of the Bombay Natural History Society (BNHS) by T.K. Mukherjee.

The following species are additions to the list of mantid fauna of SGNP and Maharashtra. Appendix 1 lists the mantid fauna of SGNP and Appendix 2 lists the mantid fauna recorded so far from Maharashtra.

A. **Family**: **Hymenopodidae** Chopard
I. **Subfamily**: **Acromantinae**
Genus: ***Euantissa*** Giglio-Tos
1. ***Euantissa pulchra****
Locality: Tulsi Lake, SGNP
Date: 30.vii.2000
Collected by: BNHS Party
Sex & Measurements: F, BL-18, PN-7, HW-18
Distribution: Eastern, northeastern and Southern India

Genus: ***Ephestiasula*** Giglio-Tos
2. ***Ephestiasula intermedia*** Werner*
Locality: Goregaon, SGNP
Date: 26.vi.1999
Collected by: BNHS Party
Sex & Measurements: M, BL-18, PN-4, FW-17
Distribution: Jammu and Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh and Orissa

II. **Subfamily**: **Hymenopodinae** Giglio-Tos
Genus: ***Creobroter*** Audinet-Serville
3a: ***Creobroter laevicollis*** (Saussure)** (NR1)
Locality: Sawantwadi, Maharashtra
Date: 18.x.2000
Collected by: BNHS Party
Sex & Measurements: F, BL-33, PN-9, FW-25

3b: Locality: Karnala, Maharashtra
Date: 15.vii.2002
Collected by: BNHS Party
Sex & Measurements: M, BL-23, PN-7, HW-25
Distribution: Andhra Pradesh, Assam, Maharashtra, Meghalaya, Sikkim, West Bengal

B. **Family**: **Mantidae** Burmeister
I. **Subfamily**: **Liturgusinae** Giglio-Tos
Genus: ***Humbertiella*** Saussure
4a: ***Humbertiella ceylonica*** Saussure*
Locality: SGNP
Date: 10.viii.1999
Collected by: BNHS Party
Sex & Measurements: M, BL-27, PN-7, FW-27
4b: Locality: Malshej Ghat, Maharashtra
Date: 7.viii.2000
Collected by: BNHS Party
Sex & Measurements: M, BL-27, PN-7, FW-27
Distribution: Assam, Bihar, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, West Bengal

5. ***Humbertiella indica*** Saussure
Locality: Nasik**
Date: 11.v.1940
Collected by: N.B. Kinnear
Sex & Measurements: Abdomen broken
Distribution: Maharashtra, Gujarat, Karnataka, Madhya Pradesh, Tamil Nadu, Uttar Pradesh

II. **Subfamily**: **Amelinae** Giglio-Tos
Genus: ***Amantis*** Giglio-Tos
6. ***Amantis biroi*** Giglio-Tos (NR2)
Locality: Andheri, Mumbai**
Date: 27.x.1934
Collected by: Charle's McCann
Sex & Measurements: M, BL-12, PN-3, FW-12
Distribution: Andhra Pradesh, Maharashtra and West Bengal

7. ***Amantis saussurei*** (Bolivar)** (NR3)
Locality: Phansad Wildlife Sanctuary, Maharashtra
Date: 15.iv.2000
Collected by: BNHS Party
Sex & Measurements: M, BL-14, PN-3, FW-13
Distribution: Andhra Pradesh, Maharashtra, Kerala and Tamil Nadu

Genus: ***Cimantis*** Giglio-Tos
8. ***Cimantis fuliginosa*** Werner* (NR4)
Locality: SGNP, Mumbai
Date: 29.v.1999
Collected by: BNHS Party
Sex & Measurements: M, BL-12, PN-3, FW-11
Distribution: Tamil Nadu, Maharashtra
(A specimen collected on 9.x.1936 present in the BNHS Collection was identified to be of this species by one of the authors TKM)

Genus: ***Gonypeta*** Saussure
9. ***Gonypeta punctata*** (De Haan) (NR5)
Locality: Goregaon, SGNP, Mumbai*
Date: 8.x.1999
Collected by: BNHS Party
Sex & Measurements: F, BL-18, PN-3, FW-35
Distribution: Karnataka, Meghalaya, Tamil Nadu and Uttar Pradesh

III. **Subfamily**: **Mantinae** Kirby
Tribe: **Miomantini** Beier
Genus: ***Deiphobe*** Stal
10. ***Deiphobe mesomelas*** (Olivier) Nymph
Locality: Phansad Wildlife Sanctuary**
Date: 2.viii.2000
Collected by: BNHS Party
Sex: Female
Remarks: Mukherjee *et al.* (1995) had recorded it in Maharashtra, but specific locality in the state was not mentioned.
Distribution: Himachal Pradesh & Maharashtra

Genus: ***Hierodula*** Giglio-Tos
11. ***Hierodula (Hierodula) saussurei*** Kirby (NR6)
Locality: Mahabaleshwar, Maharashtra**
Date: 3.vi.2001
Collected by: BNHS Party
Sex & Measurements: F, BL-70, PN-19, FW-50
Distribution: Arunachal Pradesh

12. ***Hierodula (Hierodula) doveri*** Chopard (NR7)
Locality: Phansad Wildlife Sanctuary**
Date: 1.viii.2000
Collected by: BNHS Party
Sex & Measurements: M, BL-56, PN-21, FW-46
Distribution: Karnataka, Kerala, Maharashtra, Orissa and Tamil Nadu

Genus: ***Mantis*** Linnaeus
13. ***Mantis inornata*** Werner
Locality: Vitava, Thane
Date: 22.x.1999
Collected by: BNHS Party
Sex & Measurements: N, BL-31, PN-11
Distribution: Uttar Pradesh, Maharashtra

IV. **Subfamily**: **Phyllothelinae** Beier
Genus: ***Phyllothelys*** Wood-Mason
14. ***Phyllothelys westwoodi*** (Wood-Masoni)
Locality: Andheri, Mumbai
Date: 9.viii.1936
Sex & Measurements: F, PN-5, FW-27
Remark: Old specimen, abdomen broken

Abbreviations used: NR: New record from Maharashtra; M: Male; F: Female; N: Nymph; *Species reported from SGNP; ** Species reported from Maharashtra, besides SGNP; BL: Body length; PN: Pronotum, FW: Fore wing, HW: Hind wing.

These seven additions bring the number of mantid fauna in Maharashtra to 51. The genus *Amantis* present in the collection was recently identified up to species.

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Appendix 1: Checklist of mantid fauna of Sanjay Gandhi National Park, Mumbai

Family: Amorphoscelidae Stal
1. *Amorphoscelis annulicornis* Stal

Family: Hymenopodidae Chopard
2. *Ambivia popa* Stal*
3. *Ephestiasula pictipes* (Wood-Mason)*
4. *Ephestiasula intermedia* Werner
5. *Euantissa pulchra* (Fabricius)
6. *Hestiasula brunneriana* Saussure
7. *Creobroter gemmatus* (Stoll)

Family: Mantidae Burmeister
8. *Dysaules himalayanus* Wood-Mason*
9. *Humbertiella affinis* Giglio-Tos
10. *Humbertiella ceylonica* Saussure
11. *Humbertiella indica* Saussure
12. *Humbertiella nigrospinosa* Sjostedt
13. *Schizocephala bicornis* (Linnaeus)
14. *Amantis biroi* Giglio-Tos*
15. *Cimantis fuliginosa* Werner
16. *Gonypeta punctata* (De Haan)
17. *Deiphobe infuscata* (Saussure)
18. *Hierodula* (*Hierodula*) *tenuidentata* Saussure
19. *Hierodula* (*Hierodula*) *unimaculata* (Olivier)
20. *Mantis inornata* Werner
21. *Phyllothelys westwoodi* (Wood-Mason)*

Family: Empusidae Burmeister
22. *Gongylus gongylodes* (Linnaeus)

* Old records

Appendix 2: Checklist of mantid fauna of Maharashtra

Family: Amorphoscelidae Stal

1. *Amorphoscelis annulicornis* Stal

Family: Hymenopodidae Chopard

2. *Ambivia popa* Stal
3. *Ephestiasula intermedia* Werner
4. *Ephestiasula pictipes* (Wood-Mason)
5. *Euantissa pulchra* (Fabricius)
6. *Hestiasula brunneriana* Saussure
7. *Creobroter apicalis* Saussure
8. *Creobroter laevicollis* Saussure
9. *Creobroter gemmatus* (Stoll)

Family: Mantidae Burmeister

10. *Didymocorypha lanceolata* (Fabricius)
11. *Dysaules himalayanus* Wood-Mason
12. *Humbertiella ceylonica* Saussure
13. *Humbertiella affinis* Giglio-Tos
14. *Humbertiella nigrospinosa* Sjostedt
15. *Humbertiella indica* Saussure
16. *Heterochaetula fissispinis* Wood-Mason
17. *Heterochaetula tricolor* (Wood-Mason)
18. *Schizocephala bicornis* (Linnaeus)
19. *Hapalopeza nilgirica* Wood-Mason
20. *Elmantis nira* Mukherjee & Hazra
21. *Elmantis tricomaliae* (Saussure)
22. *Eomantis guttatipennis* (Stal)
23. *Amantis biroi* Giglio-Tos
24. *Amantis saussurei* (Bolivar)
25. *Cimantis fuliginosa* Werner
26. *Gonypeta punctata* (De Haan)
27. *Deiphobe incisa* Werner
28. *Deiphobe infuscata* (Saussure)
29. *Deiphobe mesomelas* (Olivier)
30. *Deiphobella laticeps* (Wood-Mason)
31. *Hierodula* (*Hierodula*) *saussurei* Kirby
32. *Hierodula* (*Hierodula*) *tenuidentata* Saussure
33. *Hierodula* (*Hierodula*) *unimaculata* (Olivier)
34. *Hierodula* (*Hierodula*) *doveri* Chopard
35. *Hierodula* (*Hierodula*) *ventralis* Giglio-Tos
36. *Parhierodula* (*Parhierodula*) *coarctata* (Saussure)
37. *Hierodula (Rhombodera) woodmasoni* Werner
38. *Hierodula (Rhombodera) butleri* Wood-Mason
39. *Mantis inornata* Werner
40. *Mantis nobilis* Brunner
41. *Mantis religiosa* Linnaeus
42. *Statilia maculata* (Thunberg)
43. *Phyllothelys westwoodi* (Wood-Mason)
44. *Aethalochroa ashmoliana* (Westwood)
45. *Aethalochroa insignis* Wood-Mason
46. *Toxoderopsis taurus* Wood-Mason
47. *Euthyphleps curtipes* (Westwood)
48. *Paradanuria orientalis* Wood-Mason

Family: Empusidae Burmeister

49. *Empusa guttula* (Thunberg)
50. *Empusa pauperata* (Fabricius)
51. *Gongylus gongylodes* (Linnaeus)

22. NEW RECORD OF THE SALTICID SPIDER *THIANIA BHAMOENSIS* THORELL (ARANEAE: SALTICIDAE) FROM KERALA, INDIA WITH ITS REDESCRIPTION AND FIELD NOTES ON BEHAVIOUR

Although not very abundant *Thiania bhamoensis* originally described by Thorell (1895) from Burma (=Myanmar) is a common jumping spider found in many parts of Kerala state, India. We recently collected and studied a number of specimens of this spider from various parts of Kerala. Renowned salticid taxonomist Proszynski who prepared the diagrams of *T. bhamoensis* for the first time in 1984, based on the Thorell collection at Stockholm, confirmed our identification from the diagrams sent to him.

There is no previous record of this spider from India. However, Proszynski (2002) synonymized the spider *Marptusa oppressa* reported by Thorell in 1892 from Nicobar Island of India, to *T. bhamoensis*. A point we wish to highlight in this context is the close similarity between the recently collected specimens of *T. bhamoensis* and the type specimen of *Euophrys chiriatapuensis* collected by Tikader (1977) from the Andaman & Nicobar Islands, India and kept at the Zoological Survey of India, Kolkata. The descriptions and diagrams published by Tikader (1977), Proszynski (2002) also point out these similarities. We therefore suggest that the species described by Tikader as *Euophrys chiriatapuensis* be synonymized to *Thiania bhamoensis* Thorell. We provide a redescription of the species along with field notes on its behaviour.

Thiania bhamoensis Thorell

1892. *Marptusa oppressa*: Thorell, *Ann. Mag. Nat. Hist. (6) IX*: 226-237.

1895. *Thiania bhamoensis*: Thorell, Descriptive Catalogue of the Spiders of Burma, 1-406.

1901. *Thiania oppressa*: Simon, *Histoire Naturelle des Araignees, 2(3)*: 381-668.

1977. *Euophrys chiriatapuensis*: Tikader, *Rec. zool. Surv. India, 72*: 153-212.

1983. *Thiania bhamoensis*: Prószynski, *Folia*

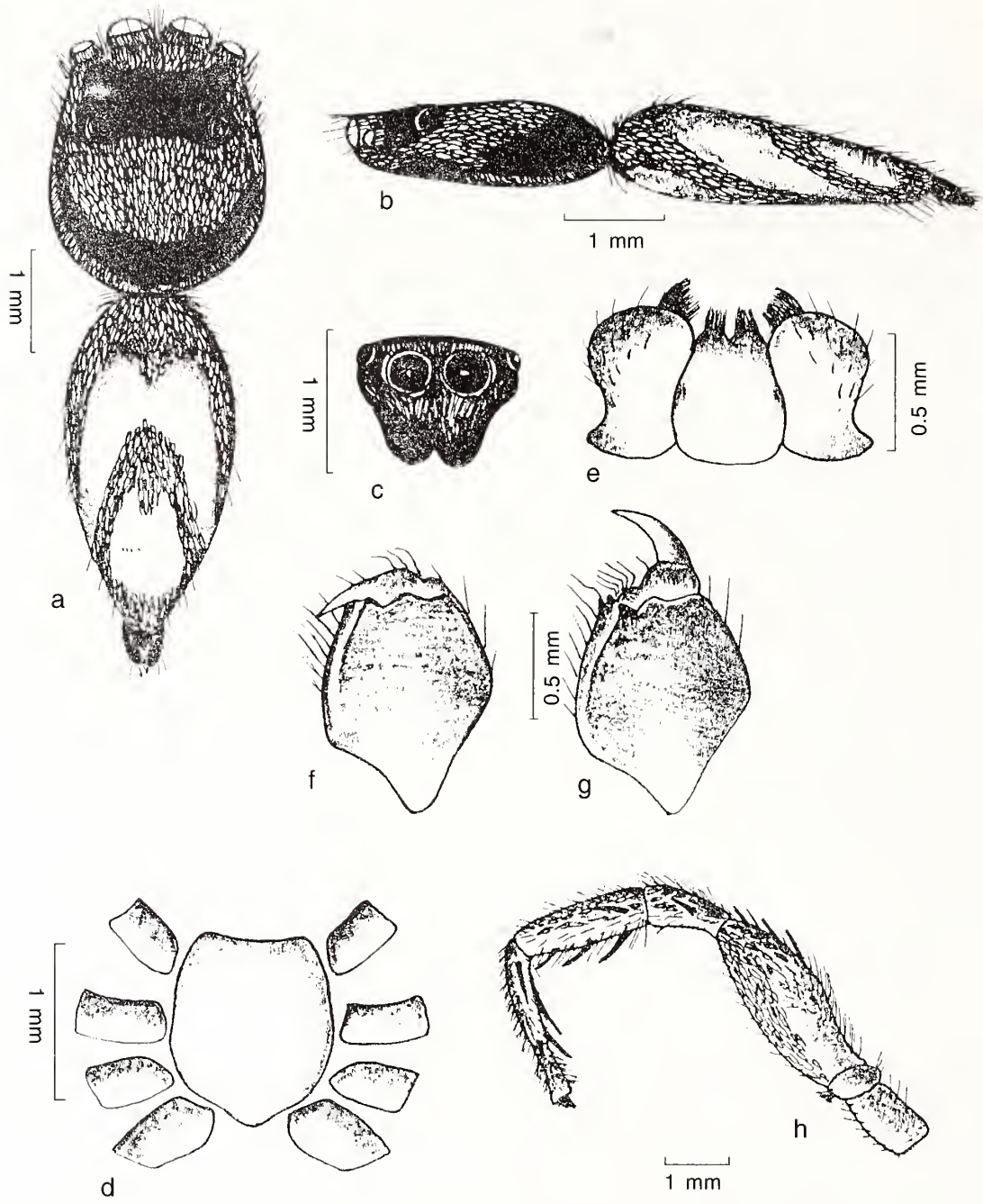

Fig. 1 (a-h): Female, *Thiania bhamoensis* Thorell
a: Dorsal aspects; b: Lateral view; c: Frontal view; d: Sternum; e: Labium and Maxilla;
f: Chelicera-fang folded; g: Chelicera-fang elevated; h: First leg - antero-lateral view

entomologica hungarica [=*Rovartani Kozlemenyek*] *XLIV*, *2*: 283-297.

1985. *Thiania bhamoensis*: Zabka, *Annals zoologici, Warszawa, 11*: 452-453.

1993. *Thiania bhamoensis*: Peng *et al. Korean Arachnol., 9*: 7-18.

1999. *Thiania bhamoensis*: Song, Zhu & Chen, The Spiders of China. Salticidae, 505-581.

Specimens examined: 5♀♀ 2♂♂, Kadavanthra, 2.viii.2000; 2♀♀ and 1♂ 3.xi.2000; 2♀♀ 15.xi.2000, Kanjoor, Ernakulam District. 1♀ 8.xii.2000 Kulathuvayal, Kozhikode District and 2♂♂ 23.xi.2001 Pookkot, Wayanad District. Collected by Samson Davis.

General: Small in size, very attractive, easily noticeable

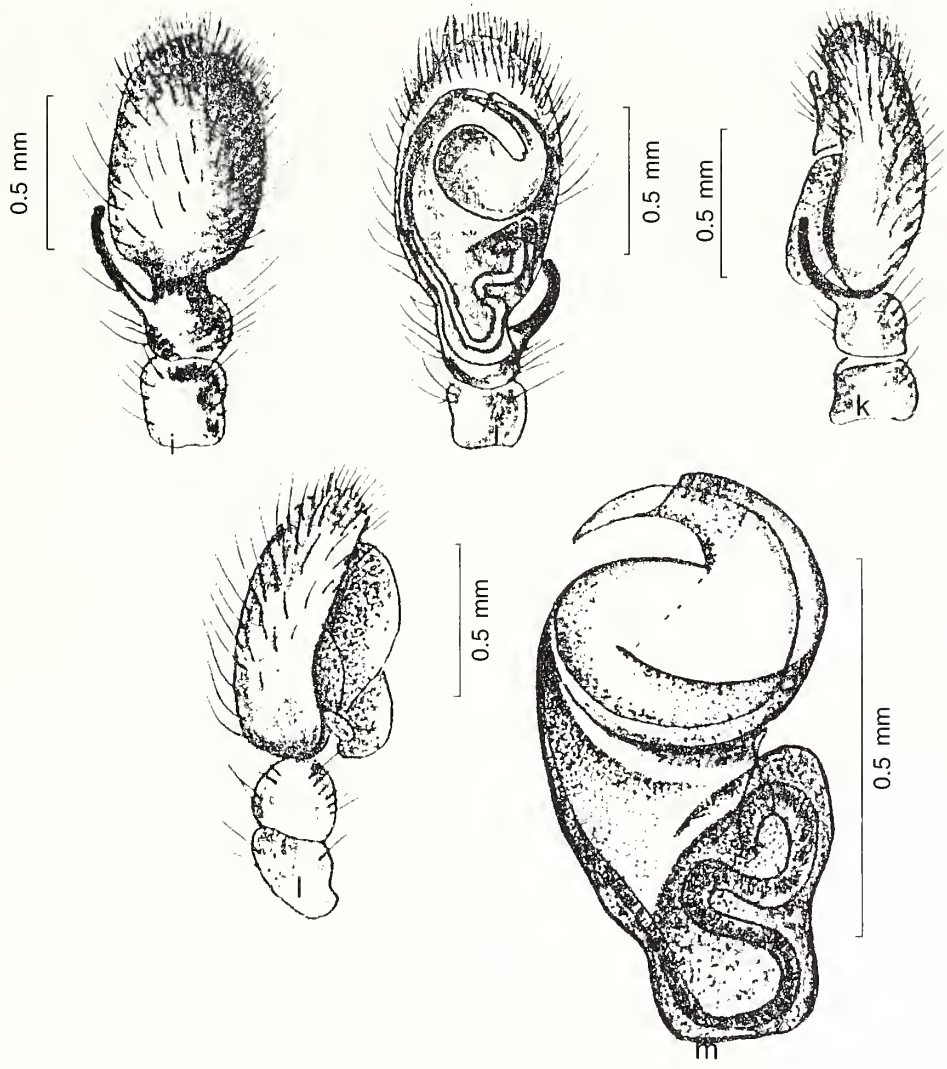

Fig. 2 (i-m): Male *Thiania bhamoensis* Thorell
i: Palp - dorsal view; j: Palp - ventral view; k: Palp - lateral view from outer side; l: Palp - lateral view from inner side; m: Palp - palpal organ enlarged

with patterns of iridescent blue or bluish green setae on cephalothorax, abdomen and legs. General body colour black. Male and female are alike, but male slightly smaller than female and darker in appearance.

Measurements (in mm): ♂ Total length - 6.88, Carapace - Maximum length - 3.13, Maximum width - 2.75, Abdomen - Maximum length - 3.75, Maximum width - 1.5.

♀ Total length - 7, Carapace - Maximum length - 2.75, Maximum width - 2.5, Abdomen - Maximum length - 4.25, Maximum width - 2.25.

Cephalothorax: Almost flat, broad not much longer than wide. Anterior row of eyes slightly recurved with eyes almost touching each other. Small black hairs present projecting from the row of eyes. Bases of anterior median eyes (AME) covered with iridescent blue hairs, anterior lateral eyes (ALE) with spindle-shaped setae of same colour. These setae also form a broad patch and spread backward to the ocular quadrangle from the base of the anterior row. Rest of ocular quadrangle without setae and black in colour. Ocular quadrangle wider than long. AME the largest. ALE and PLE (posterior lateral eyes) equal in size. Posterior median eyes (PME) minute and situated about midway between ALE and PLE. Posterior lateral eyes, almost equal in size to ALE. All eyes black in colour. Diameter of eyes (in mm) is as follows: AME - 0.6, ALE - 0.37, PME - 0.03, PLE - 0.25, Distance between eyes; AME - AME – 0, AME - ALE – 0, ALE - PME – 0.37, ALE- PLE – 0.75, PME - PLE – 0.37, PME - PME – 1.8, PLE - PLE – 1.5. Male and female alike in these measurements. A broad crescent shaped patch

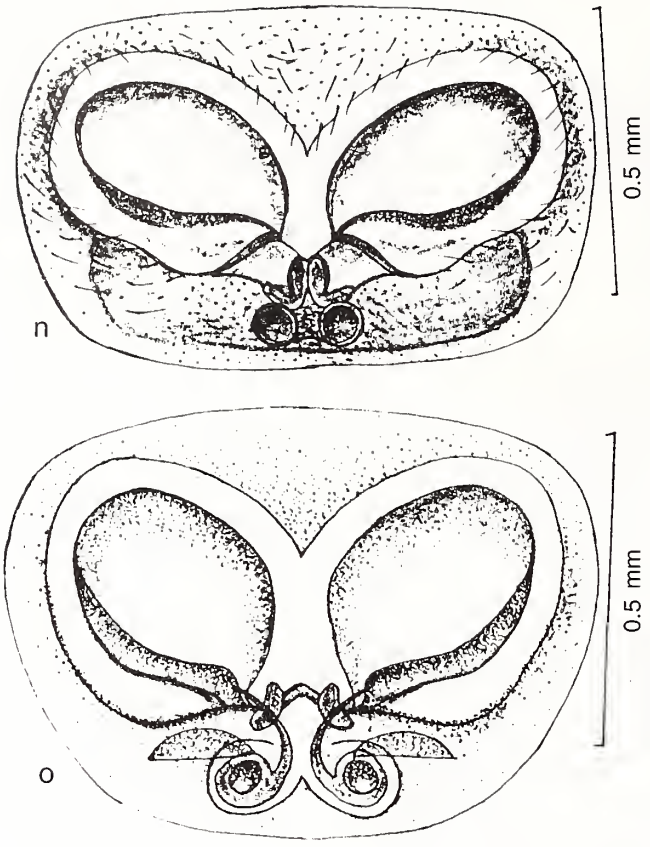

Fig. 3 (n-o): *Thiania bhamoensis* Thorell,
n: Female Epigyne; o: Female - internal genitalia

of blue iridescent spindle shaped setae present just below the posterior margin of the ocular quadrangle (Fig. 1a). Lateral rim of the cephalothorax lined with a series of same setae. Clypeus narrow and a triangular area of long flat shining hairs present below the AME (Fig. 1c).

Sternum truncated, broad with a conical posterior tip (Fig. 1d). Maxillae, with thick scopulae (Fig. 1e). Chelicerae black, round and swollen with triangular base. Two small teeth present on the outer margin and one large tooth on the inner margin almost close to the base of the fang. Fang small, curved, conical, reddish brown in colour with swollen base (Fig. 1f-g). Legs brown in colour with moderate length covered with black hairs. Femurs almost robust among which that of first leg much prominent. Three and two pairs of ventral spines present respectively on tibia and metatarsus of I and II legs (Fig. 1h). Dorsal sides of the legs with small patches of blue iridescent setae. Leg formula - 1, IV, II, III. Leg measurements of male and female provided in Tables 1 and 2.

Male palp comparatively small with hairy oval cymbium, hairs form thick tuft at the distal end. Tibial apophysis slightly curved with a blunt tip, tegulum swollen, round, embolus small, curved structure appeared to be as in a sheath. Male palp detailed in Fig. 2 (i-m). Palp in female thickly covered with small black hairs.

Abdomen: slightly elongated with broadest part at the middle. Pedicel not visible from above in live specimens. General colour of the abdomen black or light brown.

Two broad inverted "U" shaped patches formed of blue iridescent setae present on the abdomen, one situated at the upper end and the other almost at the middle. A vague mid dorsal thin line of setae present in between. Posterior end of the abdomen with a roughly triangular patch of these setae. Spinnerets, black in colour (Fig. 1a). Lower surface of the abdomen pale yellow without setae. Few faint black transverse bands present on the ventral side.

In female, the epigyne situated at the anterior end of the abdomen at the ventral side, comparatively broader with

Table 1: Leg measurements of male (all measurements in mm)

Leg	Coxa	Trocanter	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	1	0.5	2.5	1.25	2.5	1.75	1	10.5
II	0.88	0.5	1.85	1	1.25	1.25	0.5	7.23
III	0.88	0.25	1.75	0.88	1.36	1.38	0.5	7
IV	1	0.38	1.75	0.75	1.5	1.25	0.75	7.38

Table 2: Leg measurements of female (all measurements in mm)

Leg	Coxa	Trocanter	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	0.75	0.36	1.6	0.75	1.75	1	0.63	6.84
II	0.75	0.25	1.5	0.75	1.25	0.86	0.5	5.86
III	0.61	0.25	1.5	0.61	1.25	1	0.5	5.72
IV	0.86	0.36	1.13	0.75	1.5	1	0.63	6.23

two conspicuous eye-like patches light brown in colour. Two pairs of round closely fitting markings present below them. Epigyne and internal genitalia detailed in Fig. 3 (n – o).

Distribution: India, Kerala state. Observed in different parts of Ernakulam, Trichur (=Thrissur), Kozhikode and Wayanad districts of Kerala from sea level to an altitude of about 1067 m above msl.

Remarks: Blue iridescent colour of the setae fade within a very short time when specimens are preserved in alcohol. Specimens can be satisfactorily preserved in glycerine without losing colour even after one year. However, problem of shrinkage and chance of fungal attack is more while stored in glycerine. Setae in characteristic pattern present only in young and mature young adults. In "older adults" and roughly handled specimens this pattern may be lost.

Field characters: *Thiania bhamoensis* prefers plants with comparatively broad leaves. Specimens were collected from garden plants and wild bushes and even from tall trees. Unlike many other Salticids, it does not construct silk retreats, but makes a "purse-like hiding place" by sticking together two leaves with few broad vertical silk bands. Use of silk in nest construction is limited to making of these bands. Number of bands depends upon the size of the nest, which varies according to the size of the animal. This peculiar way of nest construction is perhaps characteristic of the genus *Thiania* and *T. bhamoensis* is similar in this respect to an unidentified species of *Thiania* from Malaysia as reported by Jackson in 1986.

T. bhamoensis has the habit of spending most of its time in the 'nest'. It usually remains hiding in the 'nest' with anterior parts projecting out through one of the openings of the 'nest'. In addition to protection from an intruding enemy this may also help to catch some passing insects. If disturbed while in the nest, at first the spider tries to conceal itself within the nest, then jumps out and leaps away. Sometimes it comes out of the nest for active hunting. Mosquitoes and flies are the preferred prey. When alarmed it quickly moves to the lower surface of the leaf to hide. The spider also uses the 'nest' as its night shelter. If nothing happens to the 'nest', it is used continuously for days.

Thiania bhamoensis uses the same 'nest' for oviposition and brooding. Egg sac is constructed using thick layers of silk within the 'nest'. Breeding period is usually September to November. Sitting over the egg sac within the 'nest', the mother spider guards the eggs and later the young ones until they come out of the 'nest'. After starting an independent life the young ones construct separate 'nests'. The young resemble the adult in colouration. They can be observed in fairly good numbers from January to March.

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23. FIRST RECORD OF A WIND-SCORPION (ARACHNIDA: SOLIFUGAE) FROM SEONI DISTRICT, MADHYA PRADESH

Wind-scorpions are curious creatures belonging to Order Solifugae, Class Arachnida. They resemble spiders in appearance and are also known as false-spiders, sun-spiders, and camel-spiders. They can be easily recognised by their exceptionally well-developed chelicerae forming two powerful pincers, two large eyes on an ocular tubercle, very long pedipalps, extremely hairy body, and segmented abdomen. The first pair of legs is stretched out in front and used as

tactile organ, while the remaining legs are used in locomotion (Levi and Lewi 1968). Wind-scorpions are nocturnal, exclusively carnivorous, generally preying on insects, but they also kill and eat larger animals, such as scorpions and small lizards. Principally they are desert forms, but in India they are also found in forests (Anon. 1991). A review of the literature reveals that wind-scorpions are little known in the Indian Fauna. Pocock (1900) recorded 17 species of Solifugae in 3 genera under 2 families, including three species from Central India, namely *Galeodes fatalis* Lichtenstein & Herbst, *Galeodes orientalis* Stoliczka and *Galeodes indicus* Pocock. According to Pocock (1900), *Galeodes fatalis* is known from Gwalior in Madhya Pradesh, North India, Bengal and Kathiawar; *Galeodes orientalis* from Gwalior, Kathiawar, Birbhum, Delhi, Bihar and Uttaranchal, while *Galeodes indicus* is known from Gwalior in Madhya Pradesh, Bilaspur in Chhattisgarh, Gaya in Bihar and Thane in Maharashtra. Unfortunately, since Pocock (1900), there has been no major work on the Indian Solifugae (Anon. 1991).

While identifying some arachnid fauna collected by a survey team of Zoological Survey of India, Jabalpur, from Seoni district, we came across an interesting juvenile specimen of the genus *Galeodes*, an account of which is given as follows:

Family: Galeodidae
Genus: *Galeodes* Olivier
***Galeodes* sp.**

Material examined: 1 ex. (immature); loc. Chewarighat, Seoni district, Madhya Pradesh; coll. K. Chandra, 6.vi.2001 (Regn. No. A/949).

Measurements (in mm): Total length 8; width of head 2; length of palpus 10; length of I leg 5, II leg 4.5, III leg 8.5, IV leg 13.

Colour: Cephalothorax brownish, legs light brown, abdomen blackish-brown.

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24. OCCURRENCE OF THE MUD CRAB *SCYLLA TRANQUEBARICA* (FABRICIUS) (BRACHYURA: PORTUNIDAE) FROM THE WEST COAST OF INDIA

A study of commercially important crab species of north Konkan zone, especially from ponds in Uran area of Raigad district of coastal Maharashtra revealed that, besides *Scylla serrata*, *S. tranquebarica* was also reared in the ponds. The study thus revealed that *S. tranquebarica*, which was so far reported only from India's east coast, also occurs on the west coast.

The mud crab *Scylla serrata* (Forskal), also known as mangrove swimming crab, is one of the commonest, large and widely distributed crabs in the Indo-Pacific region. Due to its large size, abundant availability close to the shore (being an estuarine species) and fetching a high price, a good deal of attention has been paid to its taxonomy and fishery (Sakai 1976; Kathirval and Srinivasagam 1992; Fuseya and Watanabe 1995; Watanabe and Fuseya 1997).

There has been confusion as to whether *S. serrata* is a complex of several species/ subspecies, or if these are morphological variations of a single species. Earlier authors preferred to use a single name for the species, namely *S. serrata*. However, from around 1949 onwards taxonomists (Estampador 1949; Serene 1952; Joel and Sanjeeva Raj 1983; Oshiro 1988; Fuseya and Watanabe 1996; Overton *et al.* 1997; Keenan *et al.* 1998; Fuseya 1998) have recognized two to four different species or subspecies. In contrast, Stephenson and Campbell (1960) attributed their morphological variations to environmental differences. Fushimi and Watanabe (2001) have reviewed the problems in species identification of crabs of the genus *Scylla*.

The use of popular names for *S. serrata* is also confusing. The common usage of "mud crabs" is rather unfortunate, as there are so many crabs – both walking and swimming – that live in mudflats. Even the term "mangrove

crab" is confusing, as this term is used for crabs of the genus *Sesarma*. Chhapgar (pers. comm.) prefers the usage of "mangrove swimming crab" as it distinguishes the swimming *Scylla* from the walking *Sesarma*.

During our survey of the fattening ponds for *Scylla* at Uran in coastal Raigad district of Maharashtra, *S. serrata* was seen to be the predominant form, occurring throughout the year. However, only during the monsoon season, we came across *S. tranquebarica* in fair numbers. Comparison of the teeth on the antero-lateral borders of the carapace and teeth on the carpus of the chelipeds and the sharpness of the teeth on the front (i.e., between the eyes) was adequate to separate the two species of *Scylla*. *S. tranquebarica* is locally called "*shen kurla*", while *S. serrata* is called "*Lal chimbori*" in the North Konkan region.

Morphometric Characters

Two male specimens of *S. tranquebarica* were collected from Uran area and preserved at the Taraporevala Marine Biological Research Station, Mumbai; measurements for both the specimens are given in Table 1.

Chhapgar (1957, 1962) has included *S. serrata* in his taxonomic work on the marine crabs of the erstwhile Bombay state (now Gujarat and Maharashtra states and Uttar Kannad district of Karnataka state). His illustration, however, shows two distinct spines on the outer face of the carpus of the chelipeds, four sharply acuminate teeth of the front (between the eyes) and nine sharply acuminate teeth on the antero-lateral borders. He states (pers. comm.) that he had referred to the papers by Estampador (1949) and Serene (1952), and was even inclined to treat the two forms (*serrata* and *tranquebarica*) as separate species. However, he ultimately preferred the then prevalent view of clubbing the two forms into *S. serrata*.

Table 1: Morphometric measurements of the specimens collected from Uran

	Measurements	Specimen 1 (Weight 850 gm)	Specimen 2 (Weight 130 gm)
i	Length of carapace	120 mm	66 mm
ii	Breadth of carapace	170 mm	93 mm
iii	Length of left cheliped	205 mm	104 mm
iv	Length of right cheliped	225 mm	114 mm
v	Length of rostrum	5 mm	3 mm
vi	Ratio of length: breadth of carapace	0.705	0.709
vii	Ratio of length of left cheliped: length of right cheliped	911	0.912

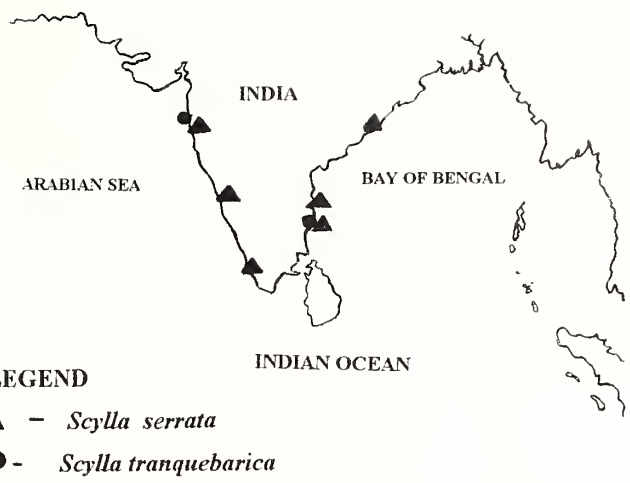

Fig. 1: Distribution of *Scylla tranquebarica* (Fabricius) on the east and west coast of India

Distribution

As per the information on geographical distribution of *S. tranquebarica* in India, the species is only reported from Parangipattai (Porto Nova) on the east coast (Anon. 1998) (Fig. 1). The occurrence of *S. tranquebarica* from north Konkan region of Maharashtra and the west coast is, therefore, confirmed by us.

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25. NEW SITES OF *NEPENTHES KHASIANA* FROM MEGHALAYA WITH NEW EASTERN AND WESTERN RANGE EXTENSIONS

The pitcher plant *Nepenthes khasiana* Hk. f. is the only *Nepenthes* species of carnivorous herbs, found in the Indian subcontinent. It is endemic to Meghalaya. *Nepenthes khasiana* was known only from the southern faces of Meghalaya plateau. Its reported western limit is Baghmara (90° 40' E) in South Garo Hills district, while the eastern limit was at Jowai in Jaintia Hills district (92° 12' E) (Rodgers and Gupta 1989). The eastern range extended recently when a site was discovered near Umtra, also in Jaintia Hills (Choudhury 2000).

I report some more sites, which were hitherto unrecorded or overlooked including new eastern and western

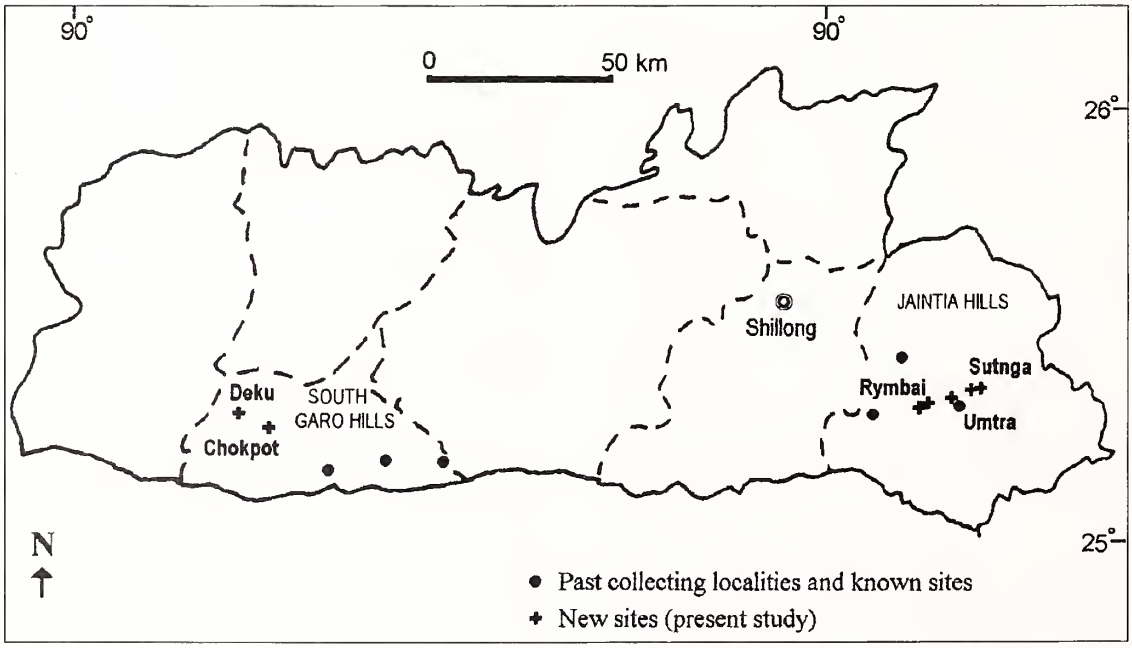

Fig. 1: Map of Meghalaya showing the localities of *N. khasiana*

range extensions of *Nepenthes khasiana*. In October 2002, a new site was found more than a kilometre northwest of the site near Umtra. This site is smaller than the earlier one and is on the left side of National Highway 44, while coming from Khliehriat. On December 14, 2002, I found many small sites scattered widely from Rymbai village (25° 20' N, 92° 20' E) (Fig. 1) towards Lakadong. I drove for another 2 km (25° 19' N, 92° 19' E) and found scattered plants. The plants reportedly occur farther down towards Lakadong, but may not be present at Lakadong. The elevation of these patches was 1100 m above msl.

I then drove east of Khliehriat. The first patch, a large one along a *nullah* was near Sutnga village (25° 22' N, 92° 26' E) at 950 m elevation. The plant is reported from all around the village, but I could not visit all the sites. Farther east, up to about 4 km east of Sutnga I found some more pitcher plants. This site (25° 21' N, 92° 27' E) at 900 m elevation is the new eastern range of *khasiana*. There was a report from a site at 92° 28' E, which I could not visit.

Towards west, I received reports of occurrence at Chokpot (25° 18' N, 90° 25' E) (Surajit Roy, pers. comm.) and Deku area (25° 20' N, 90° 21' E) (Chagla Sangma, Awal Marak pers. comm.), both in South Garo Hills district. The known west-east extent of *Nepenthes khasiana*, which was 90° 40' E to 92° 25' E, has now extended to 90° 21' E to 92° 28' E with a number of new sites (Fig. 1).

In Jaintia Hills, coal mines using crude methods and its allied activities such as clearance of forest and levelling for storage of coal, setting up of labourers' camps, truck parking, shops and hotels have become a major threat. The labourers, truck drivers, shops and hotels also need wood for fuel and heating (in winter). It is high time that the coal mining, which is the main economy of the area is modernised so that its impact on the environment can be minimised. Some of the larger patches, such as the one along the *nullah* near Sutnga village, should be protected by erecting fence and banning coal mining and felling.

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26. *LINDERNIA ESTAMINODIOSA* (BLATT. & HALLB.) MUKHERJEE (SCROPHULARIACEAE): A NEW DISTRIBUTIONAL RECORD TO ANDHRA PRADESH

The genus *Lindernia* All., comprising about 100 species (Sivarajan and Mathew 1983), is described under various generic names, such as *Lindernia* All., *Vandellia* L., *Bonnaya* Link & Otto and *Ilysanthes* Rafin. The genus is represented by 22 species in India (Sivarajan and Mathew 1983; Cook 1996) and 11 species in Andhra Pradesh (Pullaiah and Ali Moulali 1997).

While studying the aquatic and wetland angiosperm diversity in Andhra Pradesh, we came across an interesting taxon of *Lindernia* All., with a sizable population, growing in moist locality, near Tada, Nellore district, Andhra Pradesh. After a critical examination of the material with the help of literature it was identified as *Lindernia estaminodiosa* (Blatt. & Hallb.) Mukherjee. A thorough perusal of regional floras and monographs revealed that this taxon is hitherto not reported from Andhra Pradesh. A detailed description, brief account on phenology along with illustrations is given to facilitate easy field identification.

Lindernia estaminodiosa (Blatt. & Hallb.) Mukh. *In*: *J. Ind. Bot. Soc. 24*: 133. 1945.

Bonnaya estaminodiosa Blatt. & Hallb. *In*: *J. Bombay Nat. Hist. Soc. 24*: 416. 1918.

Annual, erect herb, 6-15 cm, tall; stem slender, sharply quadrangular, branched, glabrous. Leaves opposite, sessile, oblong-oblanceolate, 10-30 x 3-5 mm, 1-nerved, lateral nerves obscure, base decurrent, margin with distinctly saw-like teeth, apex obtuse. Flowers in lax terminal and lateral racemes; bract subulate, 4 x 0.2 mm, 3-nerved, margin distantly setaceous above the middle, apex acute; pedicel stout, 4 mm long. Sepals deeply 5-lobed almost to the base, 3-4 x 0.2 mm, lobes lanceolate, margin and apex setaceous above the middle, apex subacute. Petals slightly pinkish, 3 x 1.5 mm, tube linear, 2 mm

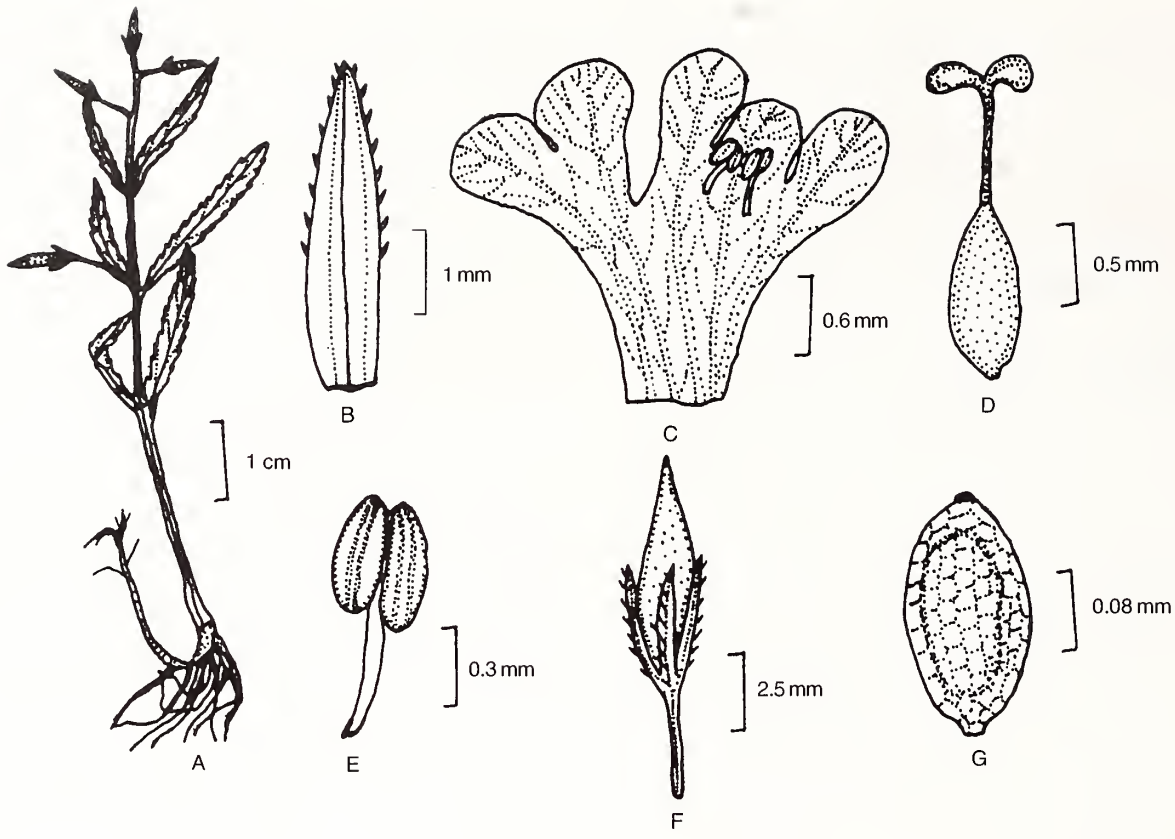

Fig. 1: *Lindernia estaminodiosa* (Blatt. & Hallb.) Mukherjee:
A. Habit; B. Bract; C. Petal; D. Pistil; E. Stamen; F. Sepals with capsule; G. Seed

long, glabrous; adaxial lip oblong-pyramidal, 2-lobed, equal; abaxial lip 3-lobed, lobes orbicular, 1 mm long; middle lobe slightly smaller than the lateral ones. Ovary elliptic, 1 x 0.5 mm; style 0.5 mm long; stigma 2-lobed, lobes orbicular, 0.5 mm long. Stamens 2; filaments 0.7 mm long; anthers unequal, 0.5 mm long, yellow; staminodes absent. Capsule cylindrical-elliptic, 10-12 x 1-1.5 mm, glabrous. Seeds oblong-orbicular, 0.25 mm long, reticulate, brown.

Ecology: Very rare in swamps.

Fl. & Fr.: October-January.

Distribution: Endemic to Southwest India. INDIA: Karnataka, Kerala, Maharashtra and Andhra Pradesh.

Exs.: Tada (Nellore district), MC 23550.

Note: It is closely allied to *Lindernia tenuifolia* (Colsm.) Alston, but differs in having larger leaf blade (10-30 mm), terminal racemes, bracts as long as the pedicels and absence of staminodes.

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27. ETHNOBOTANICAL INFORMATION OF *EULOPHIA EPIDENDRAEA* (RETZ) FISCHER (ORCHIDACEAE) IN THE KAMBLI MALAIKOVIL FOREST, TIRUNELVELI DISTRICT, TAMIL NADU

During a survey of medicinal plants of the Kambli Malaikovil forest, Kambli, Tirunelveli district, Tamil Nadu, we collected the terrestrial orchid *Eulophia epidendraea* from grassland forest growing on rocks as an epiphyte at an altitude of 50-100 m. This species is only known from two localities in southern Western Ghats, India and Africa (Abraham and Vatsala 1981). This is a new distributional record of *E. epidendraea* from the Kambli Malaikovil Forest. The medicinal use of *E. epidendraea* was recorded from the local forest dwelling Yadava community. A voucher specimen *E. epidendraea* (VMR 10) was deposited in the Environmental Carcinogenesis Research Unit, St. Xavier's College (Autonomous), Palayamkottai.

The Yadavas call *E. epidendraea* Kaattu Venkayam. The dried, powdered, bulb is taken orally in hot milk to control bronchitis, tumours, scrofulous infection of the glands of the neck and in diseases of the blood, twice daily before meals, for 20 days. This use as a drug is new to science. Further studies are in progress on systematic, phytochemical and pharmacological screening for antimicrobial properties and any potent principle(s) at ECRU.

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28. OCCURRENCE, FRUITING AND SEED MORPHOLOGY OF ENDEMIC *BULBOPHYLLUM FIMBRIATUM* (LINDL.) REICHB. F.

During a floristic survey of Kukadeshwar, Taluka Junnar, an interesting tiny epiphytic orchid was recorded on *Terminalia chebula* Retz. tree. The specimen was critically examined and identified as *Bulbophyllum fimbriatum* (Lindl.) Reichb. f. (syn. *Cirrhopetalum fimbriatum* Lindl.). It was confirmed by comparing it with old herbarium collections at Agharkar Herbarium (AHMA), Agharkar Research Institute, Pune and Botanical Survey of India, Western Circle, Pune.

The abundant occurrence of this species has been reported at Mahabaleshwar by a number of workers (Dalzell and Gibson 1861; Blatter and McCann 1906; Gammie 1906; Santapau and Kapadia 1964; Bole and Almeida 1986; Deshpande *et al.* 1993). Its occasional occurrence has been reported along Sawantwadi-Ramghat and Castle rock-Anmode areas (Vartak 1966; Kulkarni 1979). Cooke (1903-1908) reported it as apparently endemic; Sarkar (1995) described it as endemic and vulnerable. Tetali *et al.* (2000) however, do not support Sarkar (1995) on its vulnerable nature.

Hooker (1872-97) referred to *Bulbophyllum fimbriatum* (Lindl.) Reichb. f. growing in Bombay(=Mumbai) southwards along the Western Ghats. Scrutiny of herbarium specimens at AHMA, Pune and BSI, Western Circle, Pune as well as critical screening of floristic literature (Dalzell and Gibson 1861; Blatter and McCann 1906; Gammie 1906; Cooke 1903-1908; Santapau 1960; Santapau and Kapadia 1964; Hemadri 1970; Laxminarasimhan and Sharma 1991; Kothari and Moorthy 1993; Deshpande *et al.* 1993, Sharma *et al.* 1996) revealed that so far there has been no report of its occurrence beyond Satara district towards North in Western Ghats. One herbarium specimen of this species collected by H.P. Paranjape in 1908 from Ganeshkhind Botanical Garden, Pune, probably from cultivation, is the only exception. This report, therefore, is a new distributional record for this species from Taluka Junnar of District Pune.

The species was recorded at Kukadeshwar on two trees with less than 150 bulbs. The patch was studied *in situ* and *ex situ* for one complete phenological cycle. Critical observations showed some distinct variation in morphology

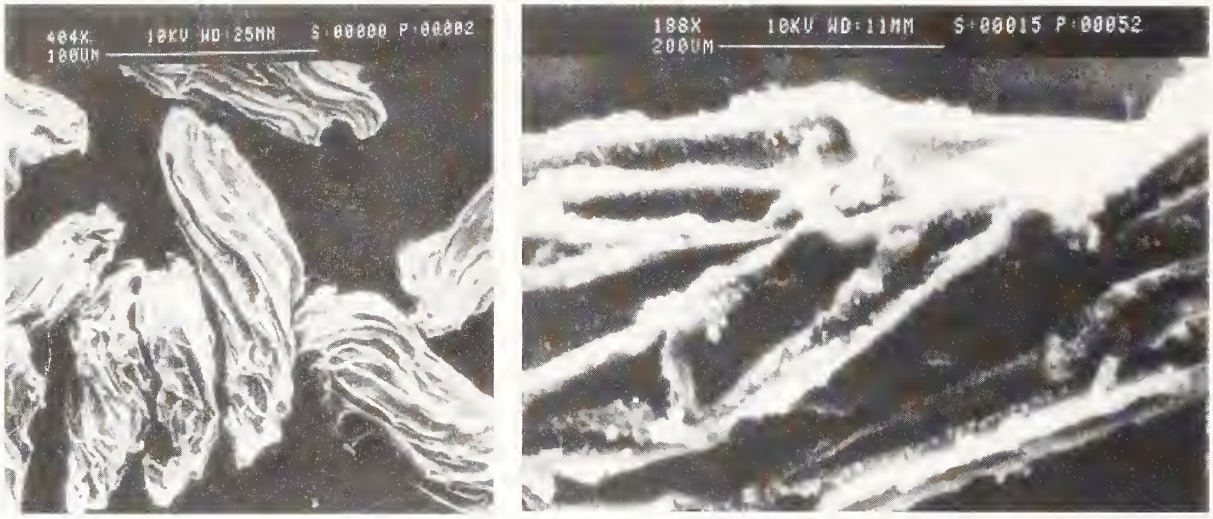

Fig. 1: SEM - Microphotographs of seed of *Bulbophyllum fimbriatum* (Lindl.) Reichb. f.

than the previous reports in literature (Cooke 1903-08; Santapau and Kapadia 1964; Sharma *et al.* 1996). They are as follows:

- Pseudo-stem with minute papillae.
- Leaves glabrous above and glaucous beneath.
- Flowers without foul scent.
- Mature fruits emit sweet fragrance.

It was interesting to note that complete morphological description of the matured fruit and seed has not been reported so far. This paper, therefore, also brings on record, fruit and seed morphology of the species for the first time. Since the seed is very minute efforts were made to study seed morphology particularly surface structures using Scanning Electron Microscope. Micro-morphology was carried out using Stereo-scan 5120 Cambridge Microscope.

During the phenological studies, fruit setting was observed only under *in situ* condition. In planted material no fruit setting was recorded though bulbs flowered profusely. In the population, 65% bulbs were recorded in flowering and 20% in fruiting state. Of these fruiting bulbs, 17% inflorescence terminated into single capsule, whereas 3% inflorescence terminated into 2-3 capsules (Fig. 1). Overall the fruit setting was very less.

The capsules are obpyriform in shape with persistent sepals at distal end. They are fragrant, green when young and become dark brown at maturity. Average size range between 4-13 mm x 1.4-4 mm. Surface longitudinally thickened with 6-8 ridges and furrows, minutely hairy along ridges. Capsules longitudinally dehiscent (Fig. 1).

The seeds are minute, light brown in colour; spindle shaped somewhat twisted near both ends. Average size ranges from 127.25-212.1 x 30.3-60.6 µm. Seed surface shows oblique striations in epidermal cell layer, which is irregularly reticulated (Fig. 1).

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29. INDIGENOUS USES OF RHODODENDRONS IN NEPAL

Nepal (total area 147,181 sq. km) has an alluring blend of various habitats and biodiversity. The snow-capped Himalayan peaks tower in a cluster to the north, while the *terai* plains, about 25 km wide, stretch to the south. The mid-land is covered by hills (about 77% of the total land mass), where many fertile valleys like Dang, Surkhet, Pokhara and Kathmandu are located. This mid-land region harbours many important Rhododendron species. It is estimated that 32 species of Rhododendron occur in Nepal, and 28 of them are found in the Jaljale and Milke areas in east Nepal. Rhododendrons have supposedly originated about 100 million years ago in the Yunan province of China (de Milleville 1993). Presently, the recorded number of rhododendrons in China is 460 species, of the 850 in the world. They range in size from 20 m (giant) to 15 cm (dwarf). Their beautiful flowers can be observed from February (1,500 m and above) to June (3,500 m and above). Dwarf species like *Rhododendron setosum* and *R. lowndesii,* which are found above the timberline, are endemic to Nepal. The common species, *Rhododendron arboreum* was designated as the National flower of Nepal in 1962.

The pollens of many species of rhododendrons are poisonous, and hence the honey collected by the wild bees becomes poisonous. Therefore, the villagers collect honey only after the flowering season of rhododendrons.

Importance and belief

Generally, *Rhododendron arboreum* bears flowers during February-May; the other species rarely flower during this period. Rhododendrons are an essential part of Nepalese life and culture. Its flowers have an important significance in religious ceremonies and are sold in urban areas, around temple premises. During this period, the villagers decorate their homes with the flower. Many poems and songs have been composed in praise of these beautiful flowers. A Nepali song written by Kshetra Pratap Adhikari and sung by the Late Narayan Gopal Gurubacharya is worth mentioning here:

Ma ta lali gurans bhayechhu
Banai bhari phuli dinchhu
Manai bhari phuli dinchhu
Phant haru lai kasle chhuchh
Bhir ma pani phuli dinchhu

This may be translated as:

"I have now become a rhododendron, and will bloom throughout the forest to allure one's heart. I will not care for the plain flat land; I will flower even in difficult sloping ground."

There is an interesting folk story concerning the beauty of the Rhododendron. The Rhododendron (*Rhododendron arboreum*), considered to be a female, once went to the Nepalese Alder (*Alnus nepalensis*), a male, with a marriage proposal. The Alder, which has a soft wooded, straight stem, turned down the proposal angrily, for she had straggling branches and looked ugly. Disappointed, the Rhododendron turned back, with no further communication with the Alder. In February-May when she flowered, covering the mountain slopes with her beautiful flowers, the Alder lamented his rude behaviour. He regretted rejecting the beautiful Rhododendron's offer and asked for forgiveness, but this time she refused to talk to him. The disappointed Alder then decided to commit suicide and jumped from a steep slope. It is believed that this is why the Alder grows around river gorges and steep slopes (Manandhar 2002).

Enumeration

This information was collected during the course of ethnobotanical studies among different ethnic groups. The plants are arranged alphabetically with botanical names, local names (Gur. Gurung; Lim. Limbu; Nep. Nepali; Sep. Sherpa; Tam. Tamang; Tib. Tibetan), and uses. The specimens are

deposited in the National Herbarium and Plant Laboratories, Godavari, Lalitpur, Nepal.

Rhododendron anthopogon D. Don; Sep. Balu chansinn, Balu Kaphe, Dhupi; Tib. Tazak-tbum.

Leaf is boiled with water for about 15 minutes, strained and the concoction is consumed as sedative. Infusion of leaf and flower is taken as substitute for tea. Dried leaves are used for incense.

R. arboreum Sm.; Lim. Thokpheklaphun; Nep. Laligurans; Sep. Tahnu mhendo; Tam. Para mhendo

Flowers are pickled, and their juice is made into a refreshing drink. Petals are chewed for their sweet and sour taste. Children suck the nectar deposited at the base of the corolla. Juice of the root and stem is used to alleviate the symptoms of asthma. Six teaspoons of bark juice, 4 times a day, is given to relieve jaundice. Paste of young leaves is applied on the forehead to cure headache. Juice of the flower is given to cure bleeding dysentery, and as an expectorant. Powdered flower or leaf is taken as snuff to stop nose bleeds, and is considered effective for curing cough and cold. The flower is believed to have powers to dissolve fish bones that get stuck in the throat and is therefore kept at home for such an emergency. The wood is good fuel as it gives heat for a long time; it is easy to cut and is used to make household utensils. Powdered leaves are used as fish poison. Young leaves are poisonous for livestock. Flowers are used to make dye.

R. barbatum Wall. ex. G. Don; Gur. Ryapu; Nep. Gurans, Gluraunsi.

Powder of tender shoots and leaves is taken as snuff to alleviate cough and cold, and also considered good for treating sinusitis. Fresh leaves and tender shoots are poisonous for cattle. Leaves and bark are used for poisoning fish. Nectar of flowers is intoxicating.

Constituents: Leaf: Andromedotoxin (Chopra *et al.* 1958).

R. campanulatum D. Don; Gur. Syapu; Nep. Anilo chimal, Cheraidu, Nilo chimal, Seto gurans; Sep. Chimal mhendo

Powder of leaf is taken as snuff for alleviating cough, cold and respiratory problems. Paste of tender leaves is applied to relieve rheumatism. Flowers are used to treat headache. Juice of immature fruit is considered good for digestive disorders. Tender leaves are poisonous for cattle.

R. campylocarpum Hook. f.; Nep. Pahenlo chimal.

Paste of tender leaves is applied to cure headache.

R. cinnabarinum Hook. f.; Nep. Sanu chimal; Sep. Balu

Fresh petals are edible. Leaves are poisonous for cattle and goats. Wood is used as fuel, but its smoke accelerates inflammation of the eye.

Constituents: Leaf: Andromedotoxin (Chopra *et al.* 1958)

R. cowanianum Davidian; Sep. Balu

Juice of bark is applied to treat cuts, wounds and boils.

R. dalhousiae Hook. f.; Nep. Lahare chimal

Bark or leaf juice is applied to treat cattle wounds.

R. falconerii Hook. f., Nep. Kurlingo

Squeezed bark is used as fish poison.

Constituents: Andromedotoxin (Chopra *et al.* 1958)

R. fulgens Hook.f.; Nep. Kurlingo

Young leaves are poisonous for cattle. It serves as good fuel wood.

R. grande Wight; Nep. Seto gurans

Juice of bark about 2 teaspoons 3 times a day is given for diarrhoea.

R. hodgsonii Hook.f.; Nep. Khorlingo

Warm juice of bark is applied to treat muscular swelling, caused by injury.

R. lepidotum Wall. ex G. Don; Nep. Sebaro, Sulu; Sep. Balul sukpa; Tam. Balu nakpo

Juice of plant is a blood purifier. In Jumla area, the villagers boil 200 gm of leaves with 4 litres of water, and sprinkle it on cots and mats to kill bugs (Manandhar 1986).

R. lendleyi T. Moore; Nep. Bhare chimal

Tender leaves are poisonous for cattle.

R. lowndesii Davidian; Tam. Barjhum mhendo

Juice of bark is applied to treat boils and pimples.

R. setosum D. Don; Nep. Jhuse sunpati; Sep. Siru, Sulu

Decoction of petals is used as substitute for tea.

R. triflorum Hook.f.; Nep. Phenla chimal

Warm juice of root is applied to treat muscular swellings, caused by injuries. Tender leaves and shoots are poisonous for cattle.

R. wightii Hook. f.; Nep. Radu

Tender leaves and shoots are poisonous for cattle.

The present study gives an account of 18 species, which are used by the local villagers. Of these, 8 species are considered poisonous to cattle, and 2 species are used for poisoning fishes. The Gurung, Lepcha, Sherpa and Tamang tribes use the leaves of *Rhododendron anthopogon* and *R. lepidotum* for incense, which is now also sold in urban markets. The petals of *R. anthopogon* and *R. setosum* are used as a substitute for tea. The petals of *R. arboreum* are eaten fresh or are pickled. Juice of petals is used as fresh drink, *sarbat* in Nepali. For medicine, 2 species each were used to treat diarrhoea and dysentery, boils and pimples, cuts and wounds, and cough and cold. Likewise, one species each was used for muscular swelling, sinusitis, jaundice and asthma.

Conservation

The main habitat of Rhododendrons is the forests, which are depleting fast, at the rate of 2.1% per year (Pudasaini 1992). Among the various reasons for this is poverty, which cannot be ignored. All species of Rhododendrons are mainly

used for fuel wood. At high altitudes near the timberline, the bushes of rhododendrons are the main source of fuel wood. In mid-hill belts, the trees are considered good fuel wood for their lasting heat, and the coal is useful to blacksmiths and goldsmiths. The wood of *R. arboreum* is soft, and is preferred for carving and making household utensils.

Rhododendrons can be protected in their natural habitat with people's participation. For instance, ecotourism can be beneficial to the locals and protect nature at the same time. A rhododendron conservation area could be established in Milke and Jaljale areas of east Nepal. Some non-governmental organisations like Echo himal, Gurans Sanrakshan Samiti are already actively conserving the rhododendrons in east Nepal.

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30. *PASPALUM CONJUGATUM* BERG. (POACEAE), A NEW RECORD TO ANDHRA PRADESH, INDIA

The genus *Paspalum* L. is represented by *c.* 250 species (Cope 1982; Sreekumar and Nair 1991; Shukla 1996). Distributed in the warmer and drier parts of the world, the genus is reported to be represented by 14 species in India (Shukla 1996). During intensive exploration of the Eastern Ghats of Andhra Pradesh, the authors collected an interesting specimen of *Paspalum* in Chintapalli forest of Visakhapatnam district. On further examination, the specimen was identified as *Paspalum conjugatum* Berg. After a thorough perusal of literature, the species is being reported as a new distributional record for the State of Andhra Pradesh.

Paspalum conjugatum Berg. in Act. Helvet. Phys. Math. 7: 129, t.8. 1772; Bor, Grass. Bur. Cey. Ind. Pak. 336. 1960.

Perennial, stoloniferous, rooting at nodes; culms to 1.1 m, surface smooth; nodes glabrous. Leaf sheaths 6-20 x 0.6-1 cm, surface glabrous, ciliate along one margin, compressed, keeled. Ligule rounded, to 1 mm, membranous. Leaf blade 17-25 x 0.7-1 cm, linear-lanceolate, surface glabrous, apex acuminate, base narrow, ciliate, margin ciliate. Racemes 2, conjugate, 6-18 cm; rachis triquetrous, glabrous. Spikelets subsessile, solitary, alternate on the rachis, 1.8-2 x 1-1.5 mm, ovate or broadly elliptic, or orbicular acute, hairy, greenish-yellow. Lower glume absent. Upper glume ovate or orbicular, 1.5-1.9 x 1-1.3 mm, membranous, 2-nerved, long ciliate along the margins. Lower lemma barren, ovate or orbicular, and acute, 1.6-1.8 x 1 mm, membranous, 2-nerved. Upper lemma ovate or orbicular, 1.5-1.7 x 1 mm, crustaceous, 2-keeled. Palea ovate, 1.5 x 1 mm, crustaceous, 2-keeled. Stamens 3, anthers

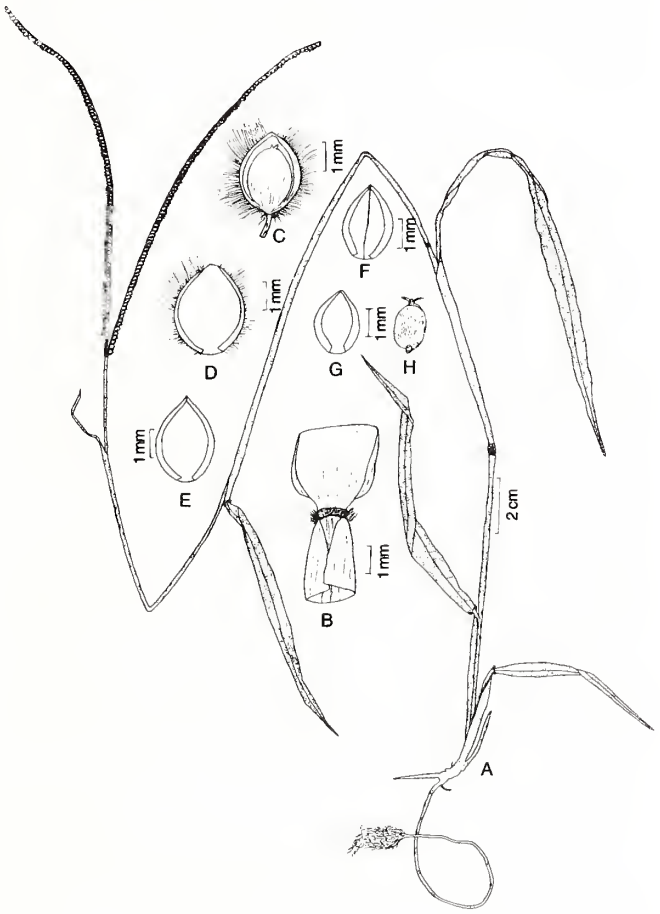

Fig. 1: *Paspalum conjugatum*
A. Habit; B. Ligule; C. Spikelet; D. Upper gulme; E. Lower lemma; F. Upper lemma; G. Palea; H. Grain

0.5 mm, deep yellow. Pistil 1 mm, stigmas white. Lodicules 0.3 mm. Grains elliptic-ovate.

Distribution

World: America, Africa and Asia (Bor 1960; Moulik 1997).

India: Peninsula, East India, Northeast India, Andaman and Nicobar Islands (Bor 1960; Karthikeyan *et al.* 1989; Moulik 1997).

Ecology: The taxon occasionally occurs in streams and moist localities of Chintapalli forest area (Visakhapatnam district).

Fl. & Fr.: July-November.

Voucher specimen: Chintapalli (Visakhapatnam district) BR & AMR 24576 (SKU)

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31. A NOTE ON THE COLLECTION OF *PTERIS PUBERULA* CHING (PTERIDACEAE: PTERIDOPHYTA) IN THE NORTH-WESTERN HIMALAYA FROM KUMAON HILLS

The occurrence of *Pteris puberula* Ching (=*Pteris nepalensis* H. Ito) of Family Pteridaceae was reported for the first time by Punetha (1985) from Lohaghat and Champawat in District Champawat as a commonly growing species. Later, Pangtey and Punetha (1987) included this species, while enumerating the pteridophytic flora of Kumaon Himalaya based on the report of Punetha (1985), in the north-western Himalaya. But these specimens were later re-identified by Fraser-Jenkins (*pers. comm.*) as a large sized *Pteris subquinata* Wall. ex Agardh and subsequently Punetha and Kholia (1989) accepted that this species does not occur in Kumaon Himalaya and that the earlier report of Punetha (1985) was certainly based on misidentification. Unfortunately, Pande (1990), Pande and Pande (2002), and Dixit and Kumar (2002) still catalogued this species from Pithoragarh and Champawat in Kumaon Himalaya based on the wrong report of Punetha (1985).

Khullar (1994) in his AN ILLUSTRATED FERN FLORA OF THE WEST HIMALAYA has clearly excluded this species based on Punetha and Kholia (1989) and suggested that this species does not occur in Kumaon in the west Himalaya.

Fraser-Jenkins (1997) has clearly pointed out that he has not seen *P. puberula* Ching as far west as near the top of Sheopuri mountain, north of Kathmandu, Bagwati zone, central Nepal and that it is abundant at higher altitudes in eastern Nepal and around Darjeeling and also Lachung in the north of Sikkim.

While compiling the fern flora of Uttaranchal, it was found that some specimens were tentatively identified as *P. puberula* Ching by Fraser-Jenkins (1994) in our Herbarium, but remained unattended for a long time thinking that they are the larger specimens of *P. subquinata* Wall. ex Agardh. However, the specimens match very well with the photograph and description given by Ito (1966) in Hara. Realising its close similarity with *P. puberula* (=*P. nepalensis*), the author sent two specimens to C.R. Fraser-Jenkins, then in Kathmandu, Nepal in 2000 for his expert comments and he identified and confirmed these specimens to be *P. puberula* Ching with a remark that this is a genuine collection of *P. puberula* Ching from Kumaon in north-western Himalaya and that all previous records were erroneous. Thus, the collection of this species in Kumaon Himalaya is certainly an addition to the fern flora of Kumaon Himalaya in particular and the north-western Himalaya in general and extends its distributional range further west to Kumaon from the central Nepal. The author is of the view that this species may be quite frequently observed,

particularly in the central and inner Himalayan ranges in Uttaranchal if proper and detailed explorations are undertaken.

A brief description, ecology and distribution are provided in the present paper to facilitate easy identification. Voucher specimens are deposited in the Herbarium, Department of Botany, D.S.B. Campus, Kumaon University, Nainital.

Pteris puberula Ching, Bull. Fan Mem. Inst. Biol. 11: 52 (1941); Ching & S.K. Wu in C.Y. Wu Fl. Xizangica 1: 71. t. f. 5-8 (1983). *Pteris nepalensis* H. Ito in Hara Fl. East. Him. 1: 466. t. 25 (1966); Dixit, Census Indian Pterid.: 71 (1984); Fraser-Jenkins, New Sp. Syndr. Indian Pterid. & Ferns Nepal: 226 (1997); Chandra, Ferns India: 41 (2000); Pande & Pande, Pterid. West. Him.: 60 (2002); Dixit & Kumar, Pterid. Uttaranchal: 57(2002).

Rhizome short, creeping; scales brown, linear, margin dark, membranaceous with short fimbriate teeth; stipes shining, glabrous, solid, reddish; lamina ovate or oblong-ovate, 40-30 cm long and 25-35 cm broad, pinnate; pinnae 4-7 pairs, linear, acuminate, sessile or shortly stalked; pinnules linear, acute, base broad; veins pinnate; veinlets simple and reaching the margin; main costae with setae, basal pinnules (rarely the second pair also) elongated and pinnate on the basiscopic side, otherwise similar, the terminal pinna at the lamina top similar to other pinnae; sori marginal, indusium membranaceous, pale brown, linear, margin entire; spores tetrahedral.

Specimens examined: Kumaon: Bageshwar District near Dwali en route to Pindari glacier, (Samant 1327).

Distribution: INDIA (Sikkim, Darjeeling, East Himalaya), Nepal, China. Grows occasionally along waysides and forest margins near Dwali.

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